Report

Assessment of Natural Resource Management Changes in Senegal in the Period 1992 to 1998 From the Knowledge, Attitudes, and Practices Surveys

Volume 3 of 3

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Report

Assessment of Natural Resource Management Changes in Senegal in the Period 1992 to 1998 From the Knowledge, Attitudes, and Practices Surveys

Volume 3 of 3

By
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Acronyms

KAP	Knowledge, attitudes, and practices
IRG	International Resources Group
USAID	U.S. Agency for International Development
SO	Strategic objective
AG/NR	Agriculture/natural resources
NRM	Natural resources management
GOS	Government of Senegal
NGO	Nongovernmental organization
KAED	Kaolack Agricultural Enterprise Development
SRP	Senegal Reforestation Project
CBNRM	Community-Based Natural Resource Management
OLS	Ordinary Least Squares

Acknowledgments

This report was produced in collaboration with a number of people and institutions. The team at SENAGROSOL-CONSULT was professional in their execution of work and exceedingly gracious as host during survey implementation and analysis. Dr. Malcolm K. Marks of the International Resources Group (IRG) played a critical role during survey design and field implementation. Oury Bah found the means to oversee survey data entry and analysis from the knowledge, attitudes, and practices surveys (KAPs) and to work closely in training SENAGROSOL staff. Xiuping Duan's patient and exhaustive efforts to place 1996 and 1998 KAP[1] data in a spatial framework and her generation of maps for this report are much appreciated. In addition, Alpha Wade, Rebecca Niec and François Faye of USAID/Senegal provided leadership and support throughout the process. To all of them, my profuse thanks are due.

[1] References in this document to KAPs for different years refer to fiscal years.

I. Objectives of the KAP Surveys and Purpose of this Report

To track changes in the use of natural resource management (NRM) practices and the context for improving NRM, the U.S. Agency for International Development (USAID) funded a series of knowledge, attitudes, and practices (KAP) surveys in 1992, 1994, 1996, and 1998. The KAPs were to contribute to understanding the relationship between USAID's programmatic activities in the sector and the impacts of those programs on the behavior of rural producers. As part of the SO2[2] impact assessment, the International Resources Group (IRG) team was asked to assist in generating sound information from the 1998 KAP and to review the combined results from the four KAP surveys. One of the principal objectives of the IRG team review was to "identify, where possible, the causes, reasons, purposes, and logic for use and nonuse of improved agriculture/natural resource (AG/NR) practices and technologies."[3]

The purpose of this report is to summarize the results emerging from the analysis of KAPs from 1992, 1994, 1996, and 1998. The emphasis of the report is on identifying and understanding NRM technology changes during the period, rather than trying to present large amounts of the data that emerged from the KAP analysis, which is available in the separate, detailed report for each KAP survey. To this end, therefore, we briefly review the scope and coverage of the KAP surveys used for the analysis. The focus then shifts to broad trends and changes in NRM technology adoption for the target region of southern Senegal. Rather than presenting and discussing results for each and every NRM technology, we highlight only the most significant results. Analysis of change in technology adoption is carried out first for household and individual technologies that USAID's program might plausibly have impacted. We then turn to NRM technologies and management approaches that are adopted and used at the village rather than the household level. The next section of the report continues with a review of the evidence on changes in the context for NRM adoption during the period 1992 to 1998. These observations on trends in NRM are integrated into the next section of the report, in which we look at characteristics distinguishing adopters and nonadopters of NRM technologies. This analysis is conducted using two approaches: a bivariate comparison of a series of variables with the adoption/nonadoption variable and then a multivariate logit statistical model of the overall likelihood of NRM adoption. In the final section of the report, conclusions and recommendations are drawn.

[2] The United States Agency for International Development (USAID) once itself funded projects. Following agency re-engineering, USAID continues to fund "activities," which contribute to achievement of specific results, which, in turn, help to achieve a "strategic objective" or SO. Programs are now funded through strategic objective agreements (SOAGs), which replaced project agreements (ProAgs). The E/NRM portfolio is now funded under a SOAG and managed by an SO team (SOT), consisting of USAID staff and key partners involved in implementing the SO activities. The term SO can, thus, refer to the overall investment program in a given sector or to the group of activities collectively funded under a specific SO.

[3] International Resources Group SO2, Terms of Reference, page 5.

II. Objectives, Scope, and Coverage of National and Project KAP Surveys

A. The 1992, 1994, and 1996 KAP Surveys

As noted in the report of the first KAP survey in 1992, the KAPs were to be a series of data-collecting efforts designed to "support monitoring of its [USAID/Senegal] development program in Senegal."[4] One important objective of the 1992 KAP survey was the generation of information sufficient to estimate the profile of households that would be more and less likely to adopt NRM technologies. The initial 1992 KAP survey included 1,377 households in the four regions of the target zone of this study: Fatick, Kaolack, Tambacounda, and Kolda. The 1994 KAP survey included 2,006 households within the target zone, whereas the 1996 KAP survey included only 702. Although earlier KAP surveys included samples in Zuiguinchor, this region was excluded from the 1998 KAP survey for security reasons. Discussion of earlier KAP surveys, therefore, focuses on results from the four regions included in the 1998 KAP survey target zone.

Table 1A: Number of Households Surveyed in KAP Surveys By Year

Region	*92*	*94*	*96*	*98*
Tambacounda	267	371	133	336
Kaolack	465	681	229	377
Fatick	330	481	165	369
Kolda	315	473	175	341
Total in 4 Regions	1,377	2,006	702	1,423

In each of the 1992, 1994, and 1996 KAP surveys, similar sampling methods and survey instruments were used. Samples were drawn from the same 1988 list of households from the Department of Census and Statistics. Sample sizes were determined to generate estimates of acceptable quality at the regional level and the level of the target zone. For a summary of the relationships of questions included on questionnaires in these three surveys and the 1998 KAP, see annex A, "Comparison of KAP Questionnaires from 1992, 1994, 1996, and 1998" by Malcolm K. Marks.

[4] R. Kite, M. Keita, and L. Thiam. February 1993. "The USAID/ANRO Knowledge, Attitudes, and Practices Survey (1992)." Report prepared by Agriculture and Natural Resources Office, USAID/Senegal, Dakar.

B. The 1998 KAP Survey

1. Design and Objectives

The 1998 KAP survey objectives included the following:

- *Generate accurate estimates of NRM technology adoption levels*. Sample size was allocated to be sufficient to test for a 10 percent change in adoption levels with an 80 percent level of confidence. The KAP resources available did not allow for a higher level of accuracy or a larger sample size.
- *Allow estimates of factors distinguishing adopters/nonadopters of NRM technology*. As per the IRG terms of reference, the 1998 KAP survey was to enable such an analysis.
- *Generate time series data on "common households."* A total of 244 households had been included in each of the 1992, 1994, and 1996 KAP surveys and were to be included and surveyed in 1998 KAP as well. Tracking these households would provide a set of panel data on changes over time.
- *Include questionnaires for household heads, leading women, and villages.* As in the 1996 KAP survey, questionnaires would be administered to household heads and leading women *(femmes leader)*. In addition, a new questionnaire was to be administered at the village level. This village questionnaire was to be administered to the village leader in the presence of other members of the village.
- *Enable comparisons with earlier KAP surveys.* The 1998 KAP team was to make that survey comparable with the questions posed on the earlier KAPs.
- *Include households in the target zone of southern Senegal*. Consonant with USAID's SO2 focus on the southern regions of Senegal, the 1998 KAP survey was also to follow this guideline. Regions included in the KAP survey were, thus, Kaolack, Kolda, Tambacounda and Fatick. Casamance was excluded for security reasons. The four regions included will be referred to as the target zone for the purposes of this report.
- *Use cluster sampling.* It was agreed to follow a method of cluster sampling, consistent with sampling approaches of earlier KAP surveys.

2. Survey Implementation

Sample selection occurred in late November 1998. Field testing of the survey questionnaires was executed soon after; the actual survey was conducted from December 20 through early January 1999. The two maps below show the distribution of selected villages across rainfall zones and ecoregions of the target zone. Survey data arrived back in Dakar by the end of January, and data analysis began soon after. Analysis of the basic set of summary tables was completed by the middle of March 1999; additional and more technical analysis will follow thereafter.

3. Interaction of the Contractor and SENAGROSOL

An important aspect of the IRG team's responsibilities was to collaborate closely with the local contractor, SENAGROSOL-CONSULT, in designing, implementing, and evaluating information from the 1998 KAP survey. The IRG team worked with experts from SENAGROSOL throughout the conduct and analysis of the 1998 KAP survey and is noted as a collaborating partner in their final report.[5] By the time this report was completed, SENAGROSOL-CONSULT had finished and delivered an exhaustive report on the KAP survey results to USAID. Included in its report is a review, technology by technology, of changes in adoption levels over time and by region within the target zone. Because that report analyzes these individual technology changes in depth, such an analysis will not be duplicated here. Rather, the focus of this report analysis is in developing an understanding of what the KAP survey data, in particular, the technology adoption data and the context data that accompany it have to offer to improving understanding of NRM. In addition, this IRG report focuses on distinguishing between adopters and nonadopters in a way that the SENAGROSOL-CONSULT report does not.

4. Issues Arising During Survey Implementation

Every field survey conducted in Senegal, the United States or elsewhere suffers from unexpected nonsampling errors. The KAP survey of 1998 was no exception. The purpose of this section is to review and explain some of the complications that arose during survey implementation so that readers can better understand the results.

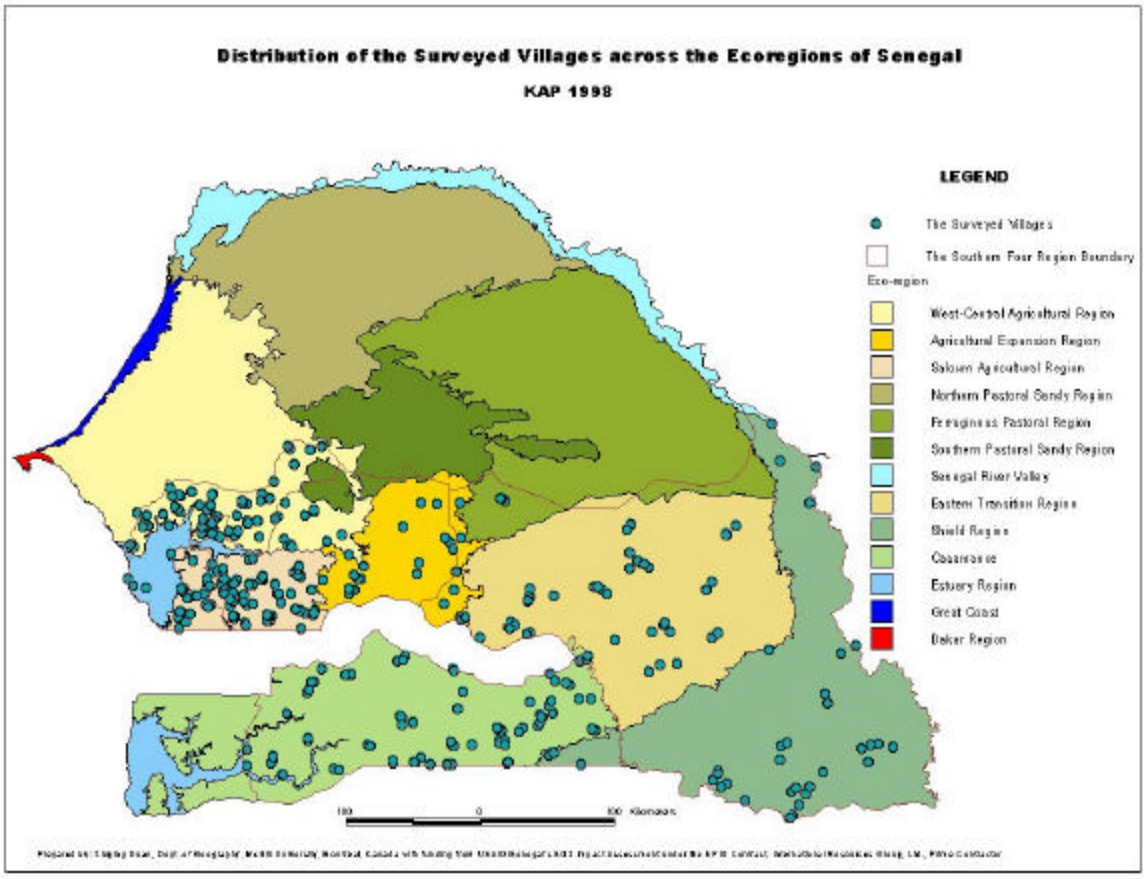
During implementation of the 1998 KAP survey, two experts from USAID joined the IRG team in tracking survey implementation and quality. Regular meetings were held between USAID, IRG, and SENAGROSOL-CONSULT to review constraints and progress. In addition, IRG arranged for its KAP consultant to be present with the SENAGROSOL-CONSULT team from the time of survey design in November 1998 through the completion of output table production in early March 1999. The IRG team believes that, although errors do exist in the 1998 KAP data, such errors should not serve as an obstacle to relying on the data for purposes of environmental planning and impact assessment analysis.

The following summarizes the important issues arising during implementation:

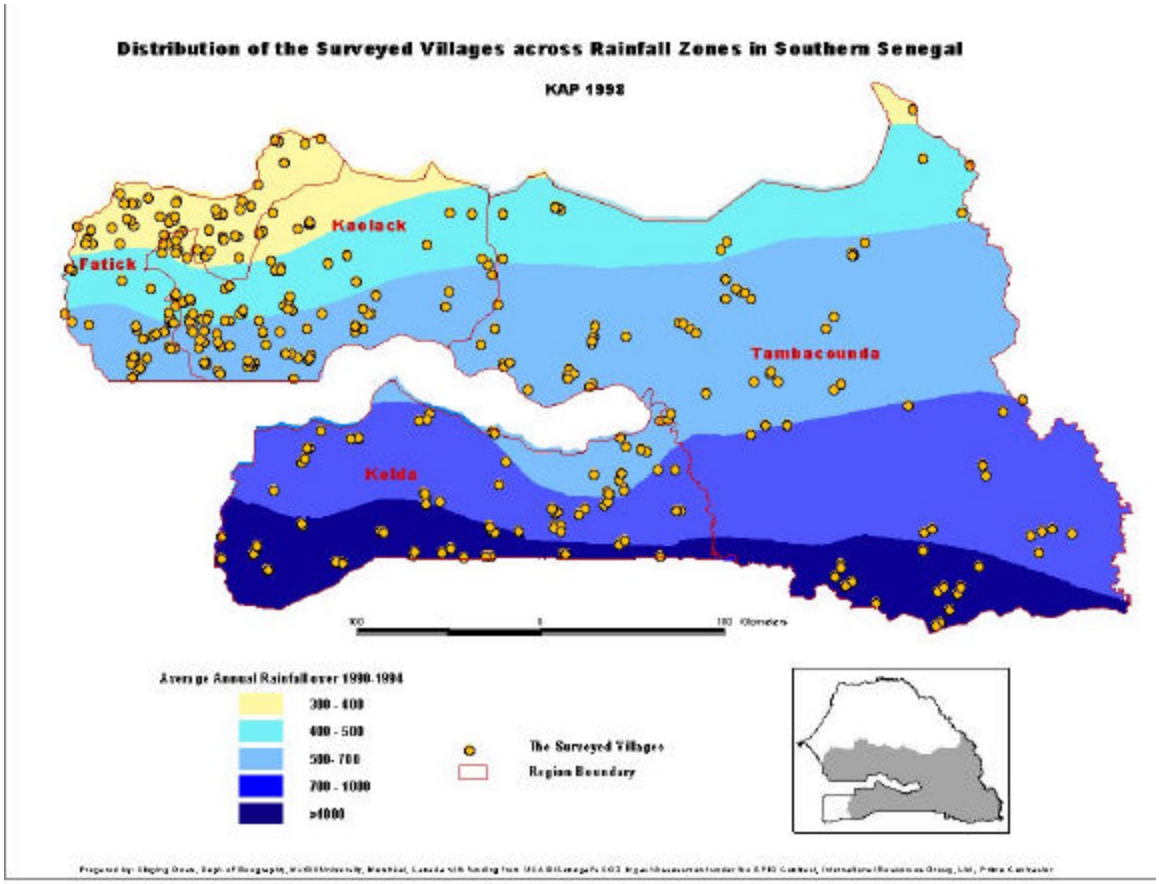
Temporary migration of household heads. Because the survey was conducted during the end-of-the-year holidays, the beginning of the month of Ramadan, and the end of the harvest season, it suffered from the absence of an unusually high proportion of household heads. Although field supervisors did not systematically record the ratio of households in which the household head was absent to the number of households visited, interviews

[5] SENAGROSOL-CONSULT in collaboration with IRG. 1998. "Etude de Connaissances, Attitudes, et Pratiques Agricoles et de Gestion des Ressources Naturelles: Enquête 1998." Vols. I and II. Produced under contract No. 685-0-00-99-00042-00 to USAID/Senegal, Dakar.

Distribution of the Surveyed Villages Across the Ecoregions of Senegal (KAP 1998)



Distribution of the Surveyed Villages across Rainfall Zones in Southern Senegal (KAP 1998)



with those supervisors confirmed that these figures were considerably higher than in earlier KAP surveys. When household heads were absent, the next highest ranking member of the household was identified to speak for him; a similar process was used for women leaders. Although it is not possible to conclude what kind of bias such absences have on survey estimates, it is safe to assume that nonhousehold head respondents cannot give as accurate responses as households heads themselves.

Problems in identifying and studying "common households." Designers of the 1998 KAP survey had hoped to track down the 244 "common households" *(ménages en commun)*, that is, those that also had been included in the 1992, 1994, and 1996 surveys. Interviewing the same sample over multiple time periods (known as using paired estimates) allows considerable reduction in variances of estimators and improvements in their accuracy. During implementation of the 1998 KAP survey, however, only 138 of the original 244 households could be found and interviewed. Because so few could be found, the decision was made not to conduct any special analysis of these households. With the number falling to only 138, any statistical benefits from using paired estimates to measure changes in NRM would be superceded by the benefits of increased sample size in the noncommon households. With a sample of 1,377 households in 1992 and another independent sample of 1,423 in 1998, comparison of independent estimates from these two samples would likely generate more accurate estimates of changes in NRM than the paired estimates.[6]

Inconsistency of technology definitions over the period of the four KAP surveys. As the KAPs evolved, definitions used in the KAP questionnaires for both technologies and NRM practices were not consistent. A summary of these changes in shown in annex B, prepared by Xiuping Duan of the IRG team. The definition of some technologies changed so significantly that they are not included in the final comparative analysis between KAP survey years. One example of this is the overlap concerning the French term "village woodlot" *(boisement villageois* from 1996) with "woodlots/orchards" *(boisement/vergers* in 1998) and "plantation/orchard" *(plantation/verger* in 1992). In some cases, overlap of these terms makes it difficult to interpret results. In the cases of most technologies, such problems do not occur.

Problems in data archiving and data entry procedures from earlier surveys. Two important and related problems related to data analysis arose during implementation. First, it became evident that comprehensive data sets from the earlier KAP surveys were not readily accessible in Dakar, either at the USAID mission or at the offices of SENAGROSOL-CONSULT. The absence of such information was important not only because of the difficulties

[6] Statistically, for the same sample size, the variance of paired estimates is one half that of independent estimates. As a rule of thumb, statisticians argue that a quadrupling of sample size is generally required to bring about a reduction of variance by one half; thus, for an independent sample to provide estimates with variances as small as those that would have been given by the 244 common households sample (had there been data available for 1998), an independent sample of about 1,000 would have been required. With more than 1,000 households each in 1992 and 1998, it was deemed advantageous to focus on the independent samples rather than the common households.

it posed for the IRG team in designing the 1998 KAP, but, more important, as evidence of the relatively low priority given to data analysis and archiving processes in earlier surveys. As survey implementation proceeded, a second problem concerning data entry for the 1994 and 1996 surveys became evident. In both cases, the data entry procedures used for NRM technologies did not allow the entry of any more than seven technologies for a given household; thus, if a household in fact adopted ten technologies in those years rather than seven, only seven would have been entered. This information raised an obstacle to direct comparison of results from the 1994 and 1996 survey results for NRM adoption to those of 1998.

Methodology of asking households about NRM adoption. An important issue concerning questionnaire administration became evident during survey implementation. In 1992 enumerators were instructed not to read any of the NRM technology names to households during the survey. Rather, households had to simply tell enumerators which technologies they were using. In all subsequent surveys, however, enumerators read the list of NRM technologies to households during the survey and then recorded which ones the household used. The 1992 results are, therefore, likely to be a low estimate of NRM adoption in this respect compared with later figures.

Variable timing of the KAP surveys. Repeat surveys such as the KAP should be carried out at approximately the same time of the year. As it happens, the USAID KAP surveys were carried out at different times of the year. In 1992, KAP questions were posed in the month of March, before planting had occurred; households were asked to reflect on their incomes and practices from the previous cropping season (June to September 1991). In both 1994 and 1996, the survey was conducted in the cropping season, although the 1994 survey was done over a short period in the month of July, whereas the 1996 survey was later in the season. In 1998 the KAP questionnaires were administered during December and January, a time period that coincided not only with the dry season (and high temporary outmigration) but also with Ramadan, Christmas, and New Year government holidays. Although no records are available to prove it, it appears that respondents in 1998, therefore, were more likely not to be heads of households (because household heads often migrate) than they were in the years when the surveys were conducted during the cropping season. Such a timing problem is not a reason to disavow the data emerging from the survey, because most household heads and women leaders were found at their homes, but it does contribute to a higher nonsampling error. Future surveys should be careful to ensure that farming practices can be actually observed by enumerators, rather than recalled by respondents and that household heads and women leaders are present during interviews.

Length of survey questionnaires. Although the 1998 KAP survey questionnaires were shortened considerably from the 1996 questionnaires, they still remained too long. A review of each of the four KAP surveys makes it clear that insufficient time for pretesting and shortening of the questionnaires allowed far more questions to remain on the survey than were included in the final analysis. Analysis of the final reports for each of the earlier KAP surveys makes this fact clear: in each of those surveys, only a small portion of survey questions are summarized in

final reports. Greater effort should be allocated in the future to ensuring that questions are not included in KAP surveys unless they have been properly tested and unless they will actually be included in output reports.

Development and adaptation of cluster sampling approach. In 1998 the number of households selected in each of the census districts was ten. Available evidence suggests, however, that these census districts are characterized by a small degree of "within cluster" variance. This is not surprising when, as is often the case, a census district falls entirely within a village or subsection of a village, in which many of the household and farming characteristics of families are similar. For reasons of obtaining better statistical efficiency in a case where cluster elements are likely to be similar (such as in a village), it is preferable to select more clusters with fewer households in each than fewer clusters with many households in each. Had raw data been available from earlier KAP surveys, such an adjustment might have been made prior to execution of this year's KAPs. Certainly, any future NRM surveys should pay special attention to this cluster variance issue, which is a critical determinant of survey output quality.

III. Analysis of KAP Results: Evolution of Natural Resource Management Technology Adoption

A. Approach

Change in adoption levels of NRM practices in the period 1992–98 is analyzed using data from the four KAP surveys conducted in the period 1992–98, subject to the limitations and constraints explained above. In this section, information is presented concerning adoption levels of major NRM technologies, including those technologies adopted and used by individual households and those adopted and used by communities. Greater importance is given to what is defined as "leading" household NRM technologies, whereas lesser emphasis is placed on "context" NRM technologies. "Leading" technologies are those for which adoption levels may plausibly have been effected by the programmatic activities of USAID during the period. Included in this group are windbreak, live fencing, tree planting, alley cropping, composting, erosion control dikes, antisalt dikes, tied ridges, retaining dikes, and improved stoves.[7] During the period of analysis, USAID encouraged the research and dissemination of appropriate adaptation of these technologies, both by creating a conducive policy environment and by strengthening institutions and approaches for dissemination.

"Context" technologies, in contrast, are those technologies for which changes in levels of adoption are presumed to occur more or less independently of USAID's programmatic activities. Included in this set of technologies are following, use of manure, use of chemical fertilizer, use of agricultural chemicals and pesticides, and crop rotation. Although proper use of these practices is generally associated with improved resource management, the practices themselves have been known and used for decades. Changes in their adoption levels generally have more to do with macroeconomic conditions and trends exogenous to the technology dissemination work with which USAID has been involved in that period than it does with USAID's contributions. Government policy concerning the subsidy of fertilizers and the effects of currency devaluation, for example, are stronger explanatory factors for changes in fertilizer use than is any NRM extension work that might have been facilitated by USAID or its partners.

In the companion analysis of survey results produced by Senagrosol-Consult, it has conducted a detailed analysis of changes in adoption levels of individual technologies during the period. Although the technology-by-technology details of that analysis are not repeated here, some general trends are presented and discussed.

[7] The corresponding French terms used in the 1998 questionnaire are *brise vent, haie vive, boisement/vergers, culture en bande, compostage, diguettes anti-erosives, digue antisel, billonage cloisonné, digue de retenue,* and, *foyer amélioré.*

B. Survey Results Related to Leading Household NRM Technologies

In this section of the report, we look at NRM technology adoption changes at the household level for the period 1994 to 1998. We use point estimates of adoption levels derived from the KAP surveys for the years 1994, 1996, and 1998. Because of the clear downward bias in the NRM technology measurements in the 1992 KAP survey (compared with 1994, 1996, and 1998), it is not used as a baseline.

As is true for the results of any sample survey, these point estimates must be understood to be associated with a degree of variation. In other words, the "true" values of adoption levels in our target population can be found by creating an interval greater and less than the estimated value. Although the size of that interval is different for every estimated technology adoption level and technology type, a safe way to create the confidence interval, given the size of the samples in the KAP, is to use a figure of 4 percent; thus, if the point estimate at the level of the target zone for adoption of live fencing is 16 percent, we can think of the true adoption level in the population as being in the range of 12 to 20 percent.

A complete set of target zone and region adoption level estimates for each of the years 1992, 1994, 1996, and 1998 are included in annex C. Target area estimates are simple weighted sums of the estimates for each of the four regions, for which the weights were the sample size for each of the regions in the respective year. Because the 1998 SENAGROSOL-CONSULT report explores these statistics in greater depth, we focus here on the broad target area and regional trends emerging from the data.

Evidence from the KAP data suggests strongly that NRM technology adoption has increased throughout the USAID target zone during the period 1992 to 1998. These increases have not been confined to one particular region or one particular type of technology, but rather are evident across many different types of technology and all of the four regions. We begin by looking at the data summarized across the full target zone and then take a closer look at the data in individual regions.

Changes in the Number of Improved NRM Practices Adopted by Rural Households in 1994 and 1998, Southern Senegal

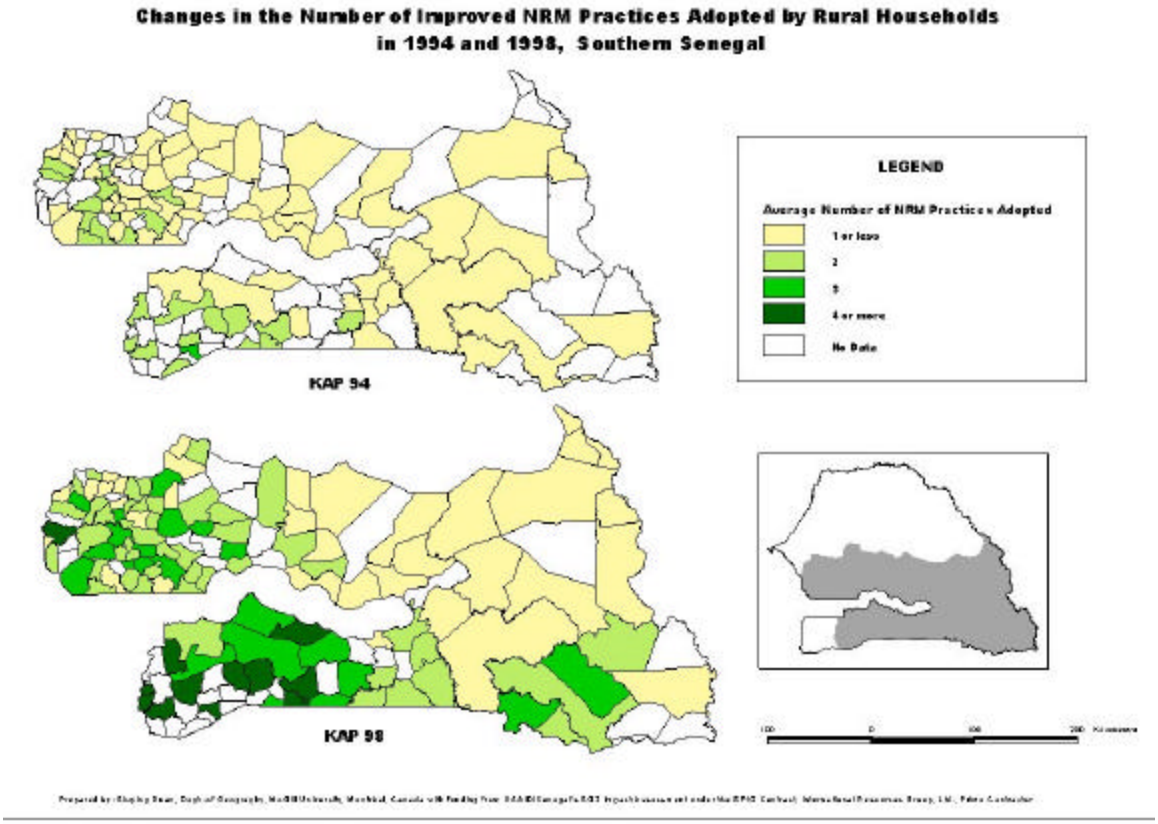


Figure 1A: NRM Adoption Changes, Water Management Technologies (1994 – 1998)

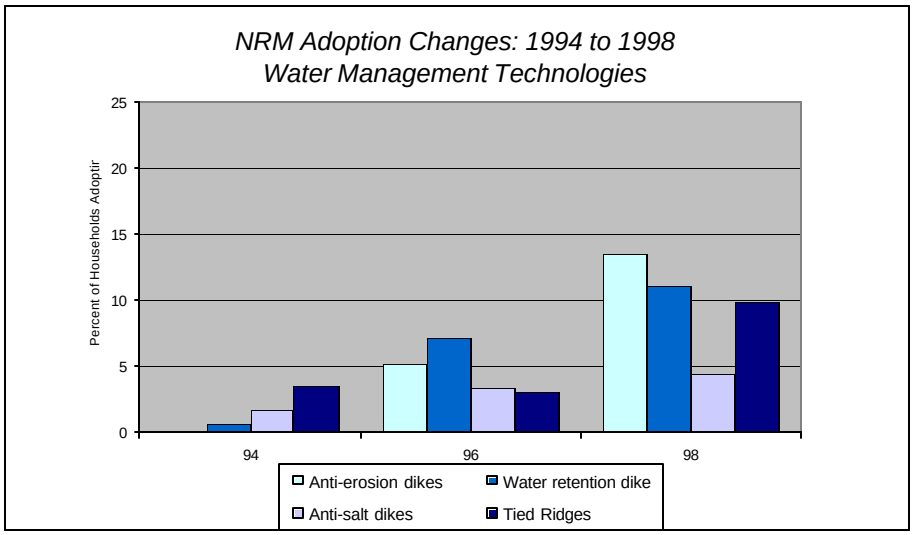


Figure 1B: NRM Adoption: Select Technologies (1996 – 1998)

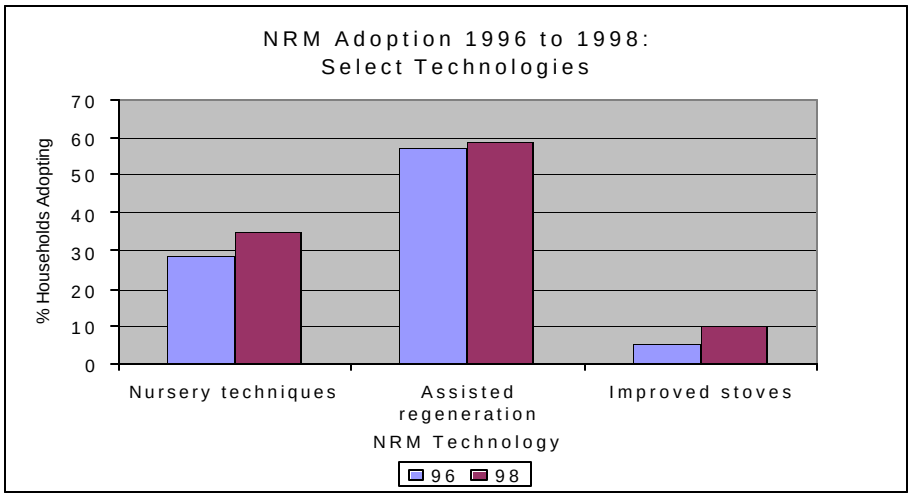
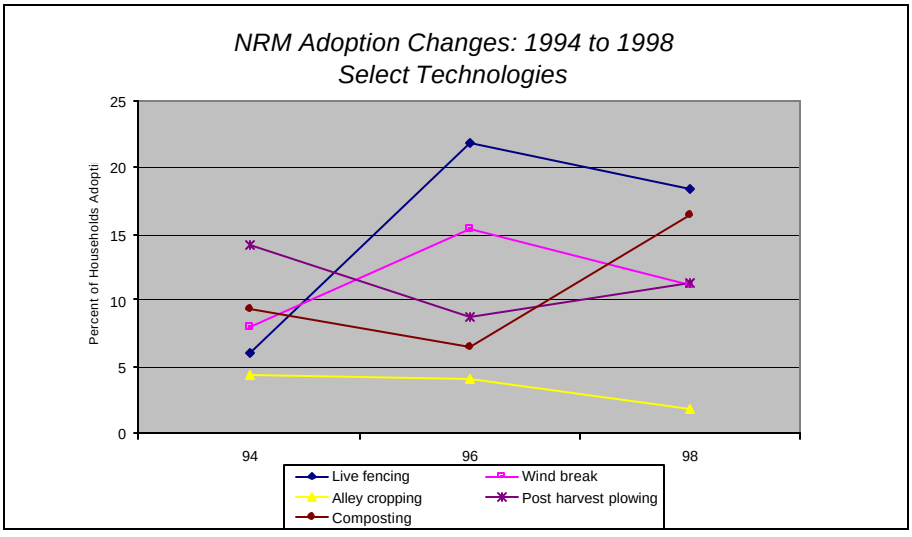


Figure 1C: NRM Adoption Changes: Select Technologies (1994 – 1998)



NRM technologies for managing water have shown consistent, although not dramatic increases in adoption levels. Virtually no households were measured using anti-erosion dikes in 1994, whereas, by 1996, 5 percent and, by 1998, 14 percent of households were using them. Similarly, for use of tied ridges, whose use by households rose by only 4 percent in 1994 to 10 percent in 1998. As shown in figure 1B for the period 1996 and 1998, adoption also appears to have increased in the use of nursery techniques, improved stoves, and assisted regeneration.

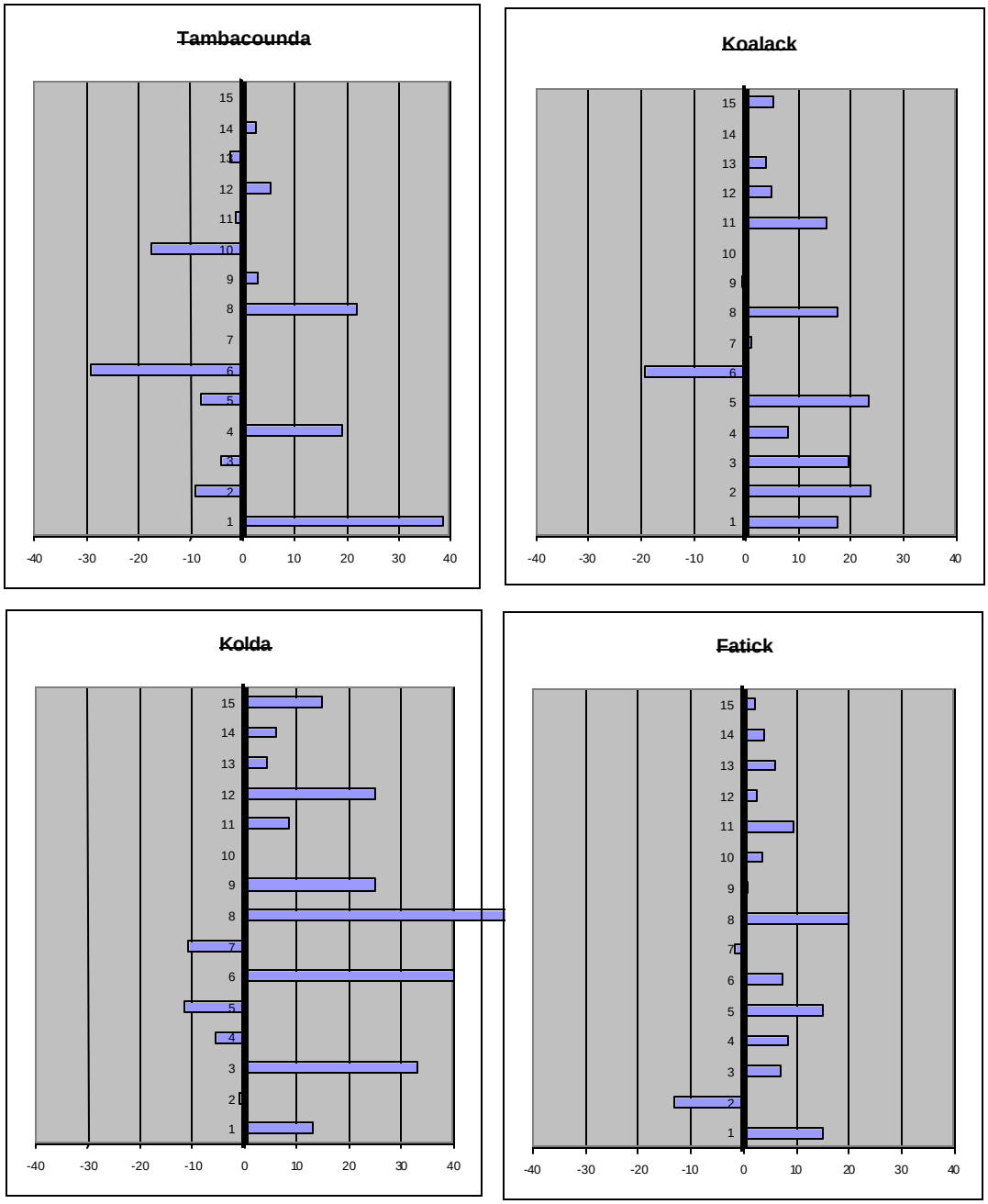
The remaining set of technologies shown in figure 1C shows quite a bit of variation at the level of the target zone, but more detailed trends at the regional level. Live fencing, a technology promoted throughout the regions by USAID-supported programs, tripled from 6 percent of all rural households in 1994 to 18 percent in 1998. Nine percent of rural households used composting in 1994 and that figure nearly doubled by 1998 to 16 percent. Windbreaks, used by 8 percent of rural households in the target zone in 1994, increased in use to 15 percent in 1994, then fell to 11 percent in 1998.

To look at the same technologies on a region-by-region basis, we have constructed a series of charts that show the percentage increase or decrease in technology adoption levels during the period 1994 and 1998. (For those technologies for which no data exist for 1994—specifically nursery techniques, assisted regeneration, improved stoves, and erosion control dikes—we use the 1996 data to compare with 1998.) The information is presented in figure 2A [see page 12]. Technologies are shown in that chart by number. The importance of the chart is not so much to compare the absolute increase or decrease of adoption levels for one technology or another (because biases may exist in comparing two years), but rather to compare NRM adoption changes on a regional basis. Direct regional comparisons of adoption growth rates, however, do not suffer from year-to-year biases in measurement. When we compare growth rates by region, these biases are cancelled out; thus, the purpose of this analysis is to compare not so much the overall levels of increase in NRM adoption, but the relative size of adoption increases across regions. A few outcomes emerge from this analysis:

Regional differences in NRM adoption during 1994–99: First, three of the four regions in USAID's target zone—Kaolack, Kolda, and Fatick—show increases in NRM technology adoption levels throughout the period, whereas one—Tambacounda—does not. The relative size of these increases is most notable in Kolda, although it is in Fatick and Kaolack that the consistency of NRM adoption increase is most evident. In Fatick and Kaolack, adoption levels in each decreased for only one of the fifteen "leading" NRM technologies included in the analysis. In contrast, adoption levels for seven different technologies decreased in Tambacounda in the same periods. These results have particular importance for assessing USAID's programmatic impact. Although it is not possible to attribute such increases directly to USAID, the consistent and broadly based increases in NRM adoption levels during the period in the areas in which USAID's programmatic presence was the strongest suggests that USAID's input was positive.

Figure 2A: Change in Adoption Levels of 15 NRM "Leading"

NRM Technologies from 1994 to 1998 by Region



Note A: The technologies included here are the following:

1. Live fencing	6. Assisted regeneration	11. Composting
2. Improved seed	7. Alley cropping	12. Water retention dike
3. Plantation/orchard	8. Field tree planting	13. Improved stoves
4. Wind break	9. Anti-erosion dikes	14. Antisalt dikes
5. Nursery techniques	10. Postharvest plowing	15. Tied ridges

Note B: The change estimates for technologies 5, 6, and 13 use change data from because earlier surveys did not include data about

Another perspective on regional changes in NRM adoption is shown in the map in figure 1C. The map compares the average number of NRM practices adopted per household in 1994 with the average number adopted in 1998. Figures are compared for the two periods at the level of *arrondissement*. An increase of 0.5—using the numbers in the map legend—implies that the average number of technologies adopted by a household in a given *arrondissement* in 1994 increased by 50 percent for the same *arrondissements* in 1998, for example, from two to four or from four to eight.

The map makes it evident that the most rapid and broadly based increases in NRM adoption can be found in the Kolda region and in scattered arrondissements in the Kaolack and Fatick regions. The concentrated growth of numbers of technologies adopted by households in the Kolda region might be explained by the migration to that region of farmers from other areas of the country bringing technologies with them—in this case especially Wolof and Serer farmers from the Sine-Saloum. The rapid increases in technology adoption in the Kolda region shown in the map also reflect the information shown in figure 2A above, in which the size of technology adoption increases in Kolda are markedly higher than in the other regions.

In addition to this overall regional trends analysis, a number of additional observations can be made about NRM adoption changes. These are as follows:

Increased use of improved seed. Evidence from the KAPs suggests *that increases in the use of improved seed have been highest in Kaolack, where use rose from 41 percent in 1994 to 65 percent in 1998, and Tambacounda, where use rose from 25 percent in 1994 to 40 percent in 1998.* Most of the "improved seed" to which farmers are referring in this question are cotton and groundnut seeds, in particular those coming directly or indirectly from SONACOS, SODIFITEC, ISRA and various projects. Part of this apparent increase in the use of improved seed may be explained by the lack of a distinction in the questionnaire between N_1 and N_{11} seed. The first category is produced on trial plots under research control. The second category of seed is cultivated by farm producers and then distributed. Because of the level of control in its production, N_1 seed is generally of higher quality than N_{11} seed. As the Government of Senegal (GOS) has reduced its agricultural spending, the amount of N_1 seed has declined. In response to this decline, more farmers have multiplied the first category of seed to create N_{11}. This explains how the formally produced "improved seed" can decline even though the KAP data show an increase. This seed use trend is a good example of farmers stepping in to fill the vacuum
left by GOS withdrawal from the sector.

Table 2A: Trees Planted In or Around Fields

Tree Species Planted	Local Name	Household	Woman	Household Head
		Head - 1998	Leader - 1998	Kolda -1998
Eucalyptus	Khot butel	9%	4%	5%
Azadirachta indica	Neem	13%	4%	6%
Anacardium occidentale	Darkasu	16%	7%	40%
Mangifera indica	Manguier	29%	16%	73%
Acacia albida	Kad	4%	2%	2%
Acacia senegal	Verek	1%	1%	3%
Citrus sp.	Agrumes	12%	5%	30%

Note: 1992 data from KAP 1992, Annex IV, page 119

Tree planting, in many forms, is on the rise. *Evidence from the 1994 to 1998 period is quite conclusive in showing increased tree planting by rural households—one of the major targets of USAID support in the period.* A number of different NRM technologies surveyed in the KAPs capture these changes, including windbreaks, field tree planting, and plantations and orchards. In each of the four regions surveyed, *the proportion of households having planted trees rose from somewhere under 16 percent in 1994 to more than 30 percent in 1998; the actual level of increase was largest in Kolda.* The type of trees planted, however, often deviate considerably from the types of trees recommended in NRM programs such as those of USAID. As shown in table 2A, both household heads and women leaders were more likely to have planted mango trees than the widely recommended neem trees or the two listed *Acacia* varieties. This preference for fruit trees is especially evident in the data for Kolda, where 73 percent of households planting trees listed mango as one type they had planted and thirty households listed citrus.

Evidence from other technology indicators supports this apparent growth in tree planting. Although the team saw few examples of windbreaks and live fencing that adhered strictly to the plant density requirements called for by NRM specialists, little doubt exists that farmers are attempting, in their own way, to expand use of these technologies. For the target zone, use of *live fencing rose from 6 to 18 percent;* the largest of these increases came in Kaolack (6 percent in 1994 to 24 percent in 1998) and the smallest came in Tambacounda (1 percent in 1994 to 4 percent in 1998). For the target zone as a whole, windbreak use rose only slightly from 8 to 11 percent of households, but increases in Kaolack and Fatick—where wind erosion is a more important constraint—were much larger. In Kaolack, *the number of households planting windbreaks rose from 2 percent in 1994 to 11 percent in 1998,* whereas the comparable figures for Fatick were 9 percent in 1994 and 18 percent in 1998.

Composting is on the rise, but varies from recommended approaches. *Target zone statistics on composting changes show an increase in adoption from 9 percent in 1994 to 16 percent in 1998.* In response to the emphasis put on composting by USAID, GOS and

other nongovernmental organization (NGO)/donor programs, it appears that adoption levels of this technology are increasing. It is important to recognize, however, that the composting referred to by farmers in the 1994 and 1998 KAP surveys were in many cases not the same technology recommended by NRM specialists. During these surveys, some confusion appears to have occurred in the interpretation of this term. NRM specialists in Senegal have been advocating the formal and organized digging of compost pits (in Wollof *neubel* and in French *fosse compostière*. Yet an unknown number of the KAP respondents who said they were composting were apparently referring instead to the use and spreading of decomposed household or farm waste (in French *ordure ménagère* and in Wollof *kan bu tos*). This second technique is much more widely used and helps explain the high adoption levels. Because this same confusion was apparently present in both the 1994 and 1998 KAP surveys, comparisons of the two time periods are valid, although absolute measures should be used with care.

C. NRM Technology Adoption at the Village Level

Table 3A: Village-based Involvement in NRM Activities, By Region, 1998

Community NRM Activity	Tamba	Kaolack	Fatick	Kolda	4 REGIONS
Village woodlot	25%	28%	53%	34%	34%
Planting wind breaks	0%	3%	3%	0%	1%
Planting live fencing	0%	3%	3%	0%	1%
Soil protection/restoration	1%	8%	3%	1%	3%
Creating fire breaks	30%	4%	0%	14%	12%
Managing controlled burning	14%	2%	5%	15%	9%
Nursery	0%	6%	0%	0%	2%
No community NRM activity	30%	46%	33%	36%	38%
TOTAL	100%	100%	100%	100%	100%

Note: Data from 1998 KAP, Village Questionnaire, Question 23. Total villages surveyed was 366.

Prior to 1998, the KAP surveys did not include questions posed directly to the village members about the use of community-based NRM activities. As part of the 1998 KAP survey, a set of questions was directed to leaders in the village, generally with multiple members of the village present to answer the questions. We look here at village members' answers to questions about what NRM activities they currently undertake as a community. Results from the survey questions on this topic are shown in table 3A and in the map on the next page.

Both the table and the map highlight the fact that the most common community-based NRM activity is the planting of village woodlots. Across the target zone, more than a third of villages identified this as one of the NRM activities that they undertook. After the planting of village woodlots, the next most common community activities are those

Type of Natural Resources Management Activities in Sample Villages, Southern Senegal (KAP 1998)

related to fire management. Although relatively rare in Kaolack and Kolda, creating firebreaks or managing controlled burning was practiced by 44 percent of villages in Tambacounda and 29 percent of the villages in Kolda. These figures, although not providing sufficient source material for a trends analysis during the period prior to 1998, may serve as useful baseline figures for the new decentralization activities of USAID and GOS.

IV. The Context for Natural Resource Management: Evidence from the 1992 and 1998 KAP Surveys

The preceding section of this report examined changes in NRM technology adoption levels during the target period of this impact assessment, to help address the question of "whether NRM adoption changed during the period or not." This section of the report looks at the evolution of conditions for NRM during the period 1992 to 1998. We begin with an examination of changes in the delivery of NRM services by GOS and other service providers during the period, of which USAID was an important one, both directly and indirectly. The services examined include *(a)* extension services for NRM technology transfer, *(b)* support in the resolution of NRM conflicts, and *(c)* financing of NRM activities by the rural council or other rural actors. The remainder of this section explores the changing conditions for NRM through a variety of lenses. We begin with changes in household perception of their well-being as well as their perceived constraints and opportunities. We then turn to stated changes in how households use products from the forest. Next we turn to an exploration of how households perceive changes in access to capital and land during the period. We then assess how households perceive some of the changes in laws and codes that have been supported by USAID. We then close with an analysis of changes in the use of animal traction, animal ownership, and farm equipment during the period.

A. NRM Service Delivery

The institutional capacity to deliver services is an important determinant of changes in NRM adoption and has also been a target of USAID's institution-strengthening efforts. This section will explore how that service delivery has changed in the period 1992 to 1998, using evidence from the KAP surveys.

1. NRM and Agricultural Extension Meetings

Table 4A: Participation in NRM/Agricultural Extension Meetings

Variable		Tamba	Kaolack	Fatick	Kolda	4 REGIONS
Households participating	***1992***	34%	38%	37%	55%	47%
Households participating	***1998***	52%	45%	56%	60%	53%
Women participating	***1998***	37%	29%	41%	32%	34%

Note: 1992 data from KAP 1992, Annex IV, page 8

During the period of USAID's investment in the target zone, an increasing number of rural households attended NRM or agricultural extension meetings in each of the major regions, with the number of households attending such meetings rising from 47 percent of all households in 1992 to 53 percent in 1998. Although these zonewide figures are perhaps not dramatic, the

rapid increases in Tambacounda and Fatick were much more so. In Tambacounda, the number of households participating in such meetings rose from 34 percent in 1992 to 52 percent in 1998, whereas the comparable figures for Fatick were 37 percent in 1992 and 56 percent in 1998. Clearly, information and advice about NRM and agricultural technologies were more readily available in 1998 than existed when the USAID program started in 1992.

2. Support in the Resolution of NRM Conflicts

Table 5A: Institutions Identified as Responsible for NRM and Conflict Resolution, 1998

Institution	*Should Manage Natural Resources*	*Should Resolve NRM Conflicts*
Central administration	8%	5%
Private sector	8%	4%
"Comite de Gestion RN"	4%	1%
Village chief	39%	48%
Village religious leader	7%	7%
"Conseil regional"	0%	0%
"Conseil rural"	20%	23%
Sub-Prefect	4%	6%
CERP	3%	2%
Other	7%	4%
TOTAL	100%	100%

One important dimension of the new SO1 on decentralized governance is that the rural council *(conseil rural)* should play an increasingly important role in the resolution of intervillage conflicts concerning natural resources. At the same time, the rationale is to devolve this authority from its traditional location with the *sous-préfet* or other regional authorities and to ensure that intervillage resource management disputes be mediated by a body more closely linked to the communities. Although table 5A does not provide a comparison of village perceptions for both 1992 and 1998, it does provide a baseline that the USAID Mission might use for its future tracking of NRM conflict management impact.

As shown in table 5A, only about one-fifth of villages in the target zone perceive the rural council as having an important role to play in managing natural resources or resolving conflicts concerning them. As of the 1998 survey, many more villages look to the village chief or other institutions to assist in managing community resources and resource conflicts.

It should be noted that this question on the village questionnaire was posed in such a way that it is not possible to determine whether respondents were referring to intervillage or intravillage resource management conflicts. Nevertheless, if posed in the same way in future years, this percentage of respondents identifying the rural council as the institution that "should" mediate NRM conflicts could serve as an important indicator of USAID program effectiveness, at least in swaying public perception about the role of the rural council. In future iterations of questions

similar to this one, USAID should be careful to identify the type of conflict and the point in the NRM conflict resolution process that are being referred to in the survey.

3. Financing of NRM Activities by Projects and by the Rural Council

Table 6A: Financing by the Rural Council of NRM Activities, 1998

Variable	Tamba	Kaolack	Fatick	Kolda	4 REGIONS
% Villages receiving rural council (RC) financing	6%	16%	18%	5%	11%
% Comm. Rurales (CR) receiving RC financing	6%	22%	34%	20%	20%
Number of villages responding	5	23	26	16	70
Type of activities financed at CR level (by number of villages)					
Village woodlot	3	9	17	1	30
Individual plantation	0	4	3	2	9
Nurseries	1	3	3	1	8
Other	1	7	3	12	23

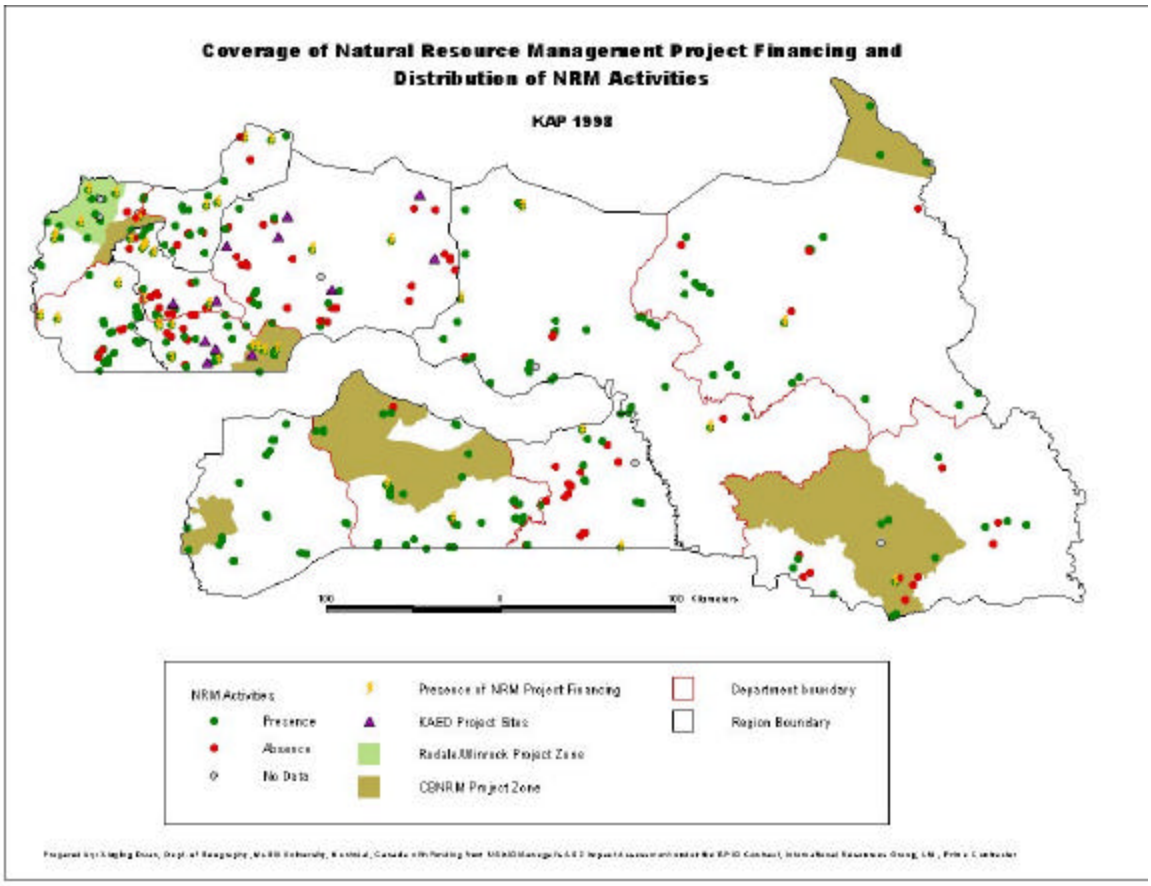
Note: Questions included in KAP 1998 Village Questionnaire, questions 24-27.

USAID's long-term goals in the target zone have been and continue to be to build the institutional capacity for rural institutions to support the process of improved resource management. One of the intended outputs of future assistance to the sector is that the rural council will have the wherewithal to provide targeted financing in support of NRM initiatives at the level of rural community and village. The 1998 KAP Survey Village Questionnaire included questions about whether the village or rural community had received any financing either from the rural council or any other projects. Results of the survey are shown in table 6A the map on page 19, and the map on the following page.

The maps and the tables make it clear that rural council financing is quite rare overall. As per the results shown in table 6A, only 11 percent of villages had received any financing from the rural council, whereas—at least per village-based declarations—20 percent of rural communities had received some sort of financing from the council. In cases in which financing was received by communities, they were more likely to use it for creating or expanding village woodlots (thirty out of seventy villages responding) than any other NRM activity.

The two maps referenced here use a lightning bolt icon to show villages where financing was received either from NRM projects or the rural council [see map on previous pages].

Coverage of Natural Resource Management Project Financing and Distribution of NRM Activities (KAP 1998)



An examination of both maps suggests that NRM project financing is relatively well dispersed around the target zone, but that rural council financing is generally bunched in the western part of the zone, as suggested by the figures in table 6A above. To validate these statistics at the level of rural communities, it would be important to follow up with a survey directly targeted to them.

B. Perceived Changes in Household Income: 1992–98

Table 7A: Current Year Income Relative to Three Years Earlier

Those saying	Respondent	From KAP	Tamba	Kaolack	Fatick	Kolda	FOUR REGIONS
"1992 better than 1989"	*Household head*	***1992***	27%	25%	22%	21%	24%
"1998 better than 1995"	*Household head*	***1998***	32%	23%	28%	34%	29%
"1998 better than 1995"	*Women*	***1998***	35%	24%	26%	34%	29%
"1992 worse than 1989"	*Household head*	***1992***	60%	72%	66%	67%	67%
"1998 worse than 1995"	*Household head*	***1998***	54%	58%	61%	59%	58%
"1998 worse than 1995"	*Women*	***1998***	55%	61%	59%	51%	57%

Note: 1992 data from KAP 1992 Annex IV, page 58

Gross domestic product or household income figures provide one means of assessing the overall economic conditions in which people find themselves at any given time. Another means of exploring people's income levels is to ask them directly. Posing the question to households in the KAPs occurred as follows. In 1992 each household was asked whether their "income was better or worse compared with three years earlier." Exactly the same question was posed in 1998 about their current income compared with 1995. Results from these questions are shown in the table.

Overall, the statistics from the two surveys suggest that rural Senegalese incomes are facing a long-term decline in the period 1989 to 1998, although the proportion of households whose incomes are declining is dropping. In 1992, 67 percent of ten rural households stated that their income that year was lower than in 1989. Six years later, in 1998, more than half of the households still stated that their income had dropped since three years earlier, although the number of households saying this had fallen from 67 percent to only 58 percent. *Households in Kolda showed the most dramatic improvements in perceived household income.* There, although only 21 percent of households said their income had

improved between 1989 and 1992, 34 percent said things had gotten better in the period 1995 to 1998.

The accuracy of these income figures is buttressed by the close responses by household heads and women leaders, in spite of their being interviewed separately. Many other questions in the KAP were answered differently by men and women, but the overall responses for men and women on this question is remarkably close.

C. Perceived Constraints and Opportunities

Table 8A: Top Three "Serious" Constraints Identified During Village Meetings, By Region

	Tamba	*Kaolack*	*Fatick*	*Kolda*
#1	Lack of infrastructure	Lack of infrastructure	Health problems	Health problems
#2	Lack of means of communication	Drought	Lack of infrastructure	Lack of means of communication
#3	Health problems	Lack of wood	Poor soils	Lack of infrastructure

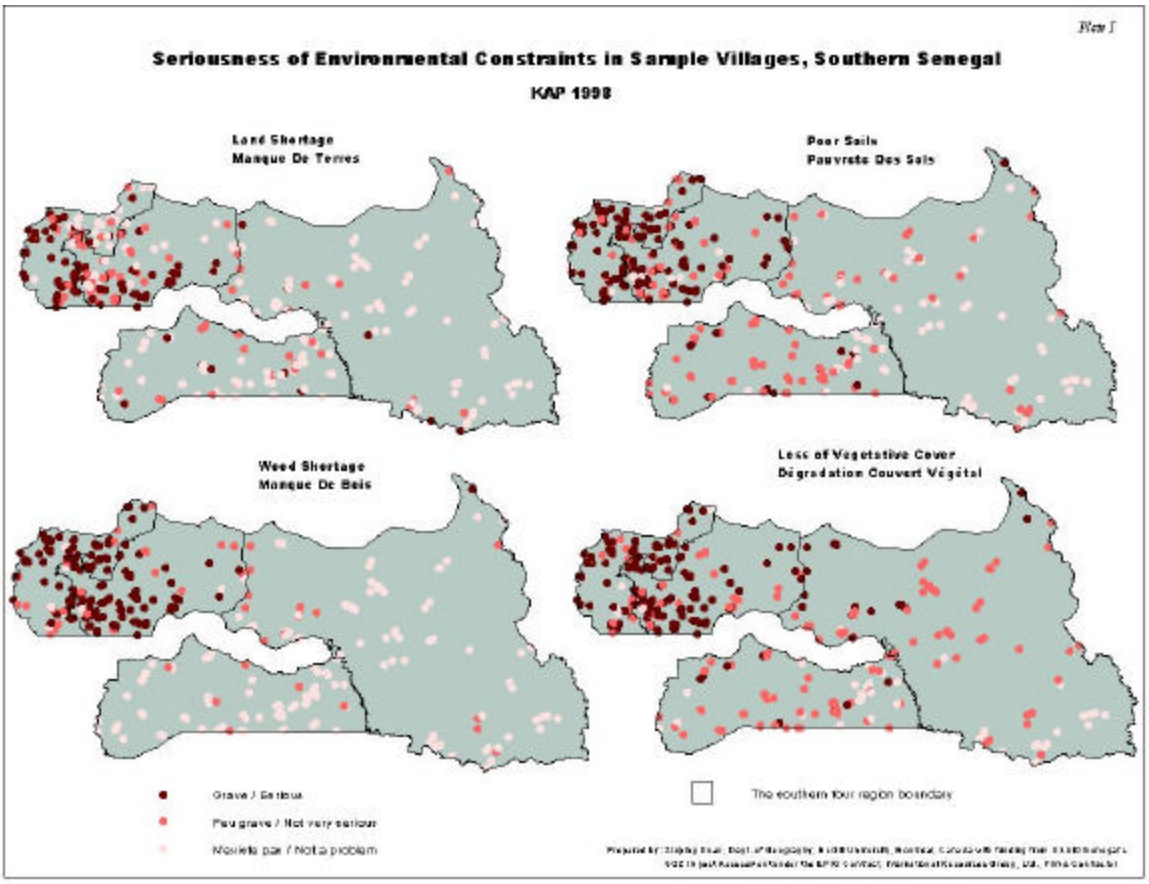
Note: "Manque d'equipements" is translated here as "lack of infrastructure."
Note: Need to get better feedback on what "manque d'equipements" meant during interview.

Programmatic success is in some measure a function of the degree to which those programs respond to constraints perceived by the target population. If rural people have no shortage of firewood for cooking, it is not likely they will be interested in village woodlots for wood production. Analysis of rural households' most "serious" constraints suggests some interesting conclusions about the priority given to environmental constraints. As shown in table 8A, *households interviewed in the regions of Tambacounda and Kolda did not include environmental problems among their top three constraints. Instead, each of those two regions included the following three constraints as the most serious to them: a lack of infrastructure, problems of health, and lack of means for communication.* Although it was not specified in the survey, it appears from discussions with field enumerators that by "infrastructure" and "means of communication," many rural people were referring to roads. *In the Fatick and Kaolack areas, in contrast, environmental constraints were noted in the form of "drought," "lack of wood," and "poor soils."* If USAID's current or future programs are to contribute to improved environmental management, they may have to appeal to another need of the local populace in the eastern and southern regions.

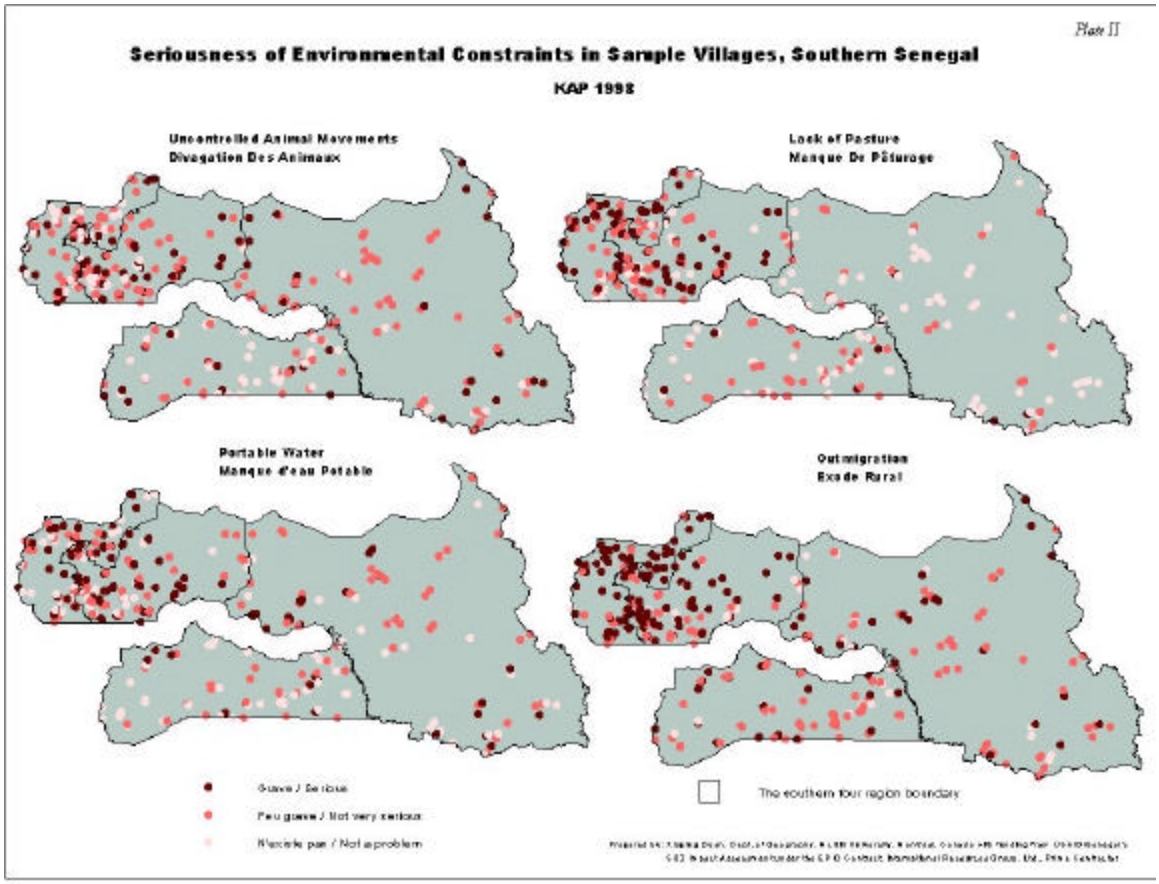
Maps produced from KAP data tell a similar story. Comparison of the maps suggests again that problems of land shortage, wood shortage, poor soils, and lack of pasture are

relatively less important in the Tambacounda and Kolda regions compared with problems of outmigration, uncontrolled animal movements, and lack of potable water. In

Seriousness of Environment Constraints in Sample Villages, Southern Senegal (Plate I)



Serious of Environmental Constraints in Sample Villages, Southern Senegal (Plate II)



the Kaolack and Fatick regions, in contrast, a higher proportion of villages ranked outmigration, wood shortage and poor soils as a "serious" constraint.

D. Use of Forest Products by Rural Households

Table 9A: "Most Important" Products Coming from Forests, as Per Rural Households

Variable	*Household*	*Household*	*Change 92-98*	*Women*
	1992	***1998***		***1998***
Firewood	94%	94%	0%	98%
Building materials	74%	72%	-2%	51%
Medicine	40%	48%	8%	38%
Fruits/nuts	55%	72%	17%	70%
Honey	17%	23%	6%	n/a
Animal feed	39%	52%	13%	39%

Note: 1992 data from KAP 92 Annex IV, page 119. Note that this includes only those households living near forests.
Additional Notes: Need to double-check the 1992 data on this.

In many areas of the world, increased income levels in rural households have been associated with a decreased reliance on locally available natural resources. With income increases and agricultural intensification, one can expect rural households to rely on purchased energy sources or livestock feed. *In contrast, where income levels are declining, households might be expected to rely more on locally available natural resources rather than those purchased in markets.* This trend appears to be occurring in the target zone in Senegal. As shown in table 9A**,** more households listed more forest products as among the "most important" in 1998 compared with 1992. Those households saying that animal feed and fruits and nuts were among the "most important" products coming from forests rose by 17 percent and 13 percent respectively during the period. Increased subregional export of forest fruits and nuts may explain the increased importance of those products. In what may be a response to devaluation and the consequent difficulty of obtaining imported medicine, 8 percent more households in 1998 said that medicine was one of the "most important" forest products, compared with 1992. To the extent that these changes in levels of importance reflects an increased commercialization of forest products, the USAID Mission's SO on private sector development might pay special attention here. *If forest products are being commercialized at an increasing rate, such commercialization can provide incentives both for conservation and destruction of forest resources.*

E. Credit Received and Investment Preferences to and Use of Capital by Rural Households

Table 10A: Credit Received by Households, Region, Gender, and Type of Credit, 1998

Type of Credit Received	Recipient	Tamba	Kaolack	Fatick	Kolda	FOUR REGIONS
In kind	*Men*	31%	48%	16%	38%	33%
In cash	*Men*	3%	8%	7%	4%	5%
In cash or in kind	*Men*	33%	52%	24%	41%	37%
In kind	*Women*	14%	12%	9%	18%	13%
In cash	*Women*	7%	9%	9%	4%	7%
In cash or in kind	*Women*	16%	18%	15%	19%	17%
In kind	*Total*	23%	30%	13%	29%	24%
In cash	*Total*	5%	8%	8%	4%	6%
In cash or in kind	*Total*	26%	35%	20%	30%	28%

Note: KAP 1998

Table 11A: Stated Investment Preferences by Gender

Preferred Sector	Household Head - 1998	Women Leader - 1998	Women Kolda -1998	Women Fatick -1998
Ag. Equipment/Machinery	16%	5%	9%	2%
Commerce	30%	52%	59%	50%
Purchase of Land	0%	0%	1%	0%
Livestock	32%	21%	8%	32%
Gardening	2%	3%	5%	1%
Forestry	0%	0%	1%	0%
Production Inputs	8%	11%	9%	12%
Other	12%	8%	8%	3%
Total	100%	100%	100%	100%

Note: Complete regional information on this table can be found in "Domaines d'investissement des credits par Region." Respondents were asked in what sector they would use credit, if they were to receive it.

The 1998 KAP survey provides a clear picture of the differential access to capital by rural men and women. The percentages of men and women who had access to credit in cash was approximately the same for the target zone; 5 percent of men and 7 percent of women received credit in cash. *But the more common form of receiving credit was far more heavily biased toward men. Across the target zone, 37 percent of men interviewed stated that they had obtained credit either in cash or in kind, whereas the figure for women interviewed was*

only 17 percent. And this "gender gap" was most stark in the Kaolack region, precisely where the greatest portion of USAID investment has occurred. There, 52 percent of men received credit in cash or kind, whereas only 18 percent of women did. These figures might serve as a useful point of departure for any future efforts by GOS or donors to enhance women's ability to obtain capital for rural investments.

The information presented in table 11A shows that *gender differences affect not only access to capital, but also how rural men and women would like to use that capital if they were to obtain it.* In general, men had a greater diversity of priorities for using capital; 32 percent of them said they would use it for livestock, 30 percent for commerce, and 16 percent for agricultural machinery. More than half of women, however, would prefer to invest in commerce if given the chance, with only 21 percent saying they would invest in livestock. Although the desire to invest in commerce is consistent for women throughout the target zone, considerable differences exist in the priority women give to investing in livestock. Although in the Fatick region, 32 percent of women say they would invest in livestock, only 8 percent would do so in Kolda. As USAID, GOS, and other donors design programs to increase capital access in rural areas, it would be wise to use these stated preferences as a starting point.

F. Land Tenure and Land Availability

Table 12A: Land Tenure and Land Availability, 1992 and 1998

Variable		n	Tamba	Kaolack	Fatick	Kolda	4 REGIONS
% Households at risk	***1992***	*37*	4%	3%	1%	4%	3%
of losing land	***1998***	*94*	6%	8%	8%	7%	7%
Strategies for preventing loss							
Plant trees	***1998***	*31*	44%	0%	27%	62%	31%
Build a fence	***1998***	*28*	33%	24%	42%	15%	28%
Justification des parcelles	***1998***	*13*	0%	21%	15%	12%	13%
Other strategies	***1998***	*27*	23%	55%	16%	11%	28%
% Households free to	***1992***		8%	12%	13%	5%	10%
sell lands	***1998***		35%	32%	12%	20%	25%
% Villages with fallow	***1998***		80%	27%	30%	82%	54%
% Villages w/ tenure problems	***1998***		38%	43%	61%	38%	45%

Note: 1992 data from KAP 1992, Annex IV, page 43

Households throughout the target zone perceive that land markets are becoming increasingly commodified during the period 1992 to 1998, a trend that may have important ramifications for the activities under USAID's new SO2. As shown in table 12A, the proportion of households

understanding that they were "free to sell their lands" rose from one out of ten rural households in 1992 to one out of four in 1998. In the eastern areas of Tambacounda and Kolda, this increased perception of land transferability was even more marked, rising from 8 percent of households in Tambacounda in 1992 to more than a third of households in 1998 and from 5 percent of households in Kolda in 1992 to 20 percent in 1998. The rapid increase in Kolda may reflect the increased migration into that region and a greater frequency of land exchange and sale. These data suggest that households are considerably more aware of land transfer issues and opportunities now than they were six years ago. To the extent that the new USAID SO2 focuses on opportunities for using land as an economic asset, such an increased market orientation of households may help to spur related activities along.

It is especially notable that, although households may perceive an increased ability to sell their lands, their perceptions do not mesh well with the current legal and policy structure. In fact, the legal framework does not greatly facilitate land transfers. Although the KAP data do not provide additional information about which lands households feel free to sell, follow-up visits to select households might explore this question further.

The downside of increasing transferability of land may sometimes be an increased risk of losing land. As the number and value of land transfers increase, some households may have their land taken out of their control by force. Evidence for the target zone, however, suggests that the perceived risk of losing land is quite low, although it has increased in the period 1992–98. Across the target region, 3 percent of households perceived a risk of losing some of their lands in 1992; this percentage increased to 7 percent in 1998. Although these levels of risk are generally low, it is worth noting that the levels of increased risk were most noticeable in Kaolack and Fatick, where the number of households at risk in 1998 rose to 8 percent of the total households. The risk data suggest that this indicator should be monitored in coming years to be sure that continued land commercialization is not accompanied by increased risk of land loss.

Those households at risk of losing their lands employed two major strategies for protecting themselves: they built fences around the land, and they planted trees on them. Each of these protective strategies were employed by roughly a third of those at risk of losing land, although the tree planting strategy was much more common in the eastern portion of the zone (Tambacounda and Kolda). The practice of putting tree or fence boundaries around parcels as a means of securing them (bandage) appears to be common where families are trying to hold onto land for family members who have emigrated from the village but are expected to return. Such evidence of land securitization makes it clear that NRM technology adoption (in this case, tree planting) is part of a multi-objective strategy of rural households, in which those objectives include not only improved resource management but also practical means of protecting land assets from risk of loss through trade. Indeed, it may be that the very practice of marking land with trees or fences, as measured here, would serve as an effective indicator of land insecurity or land conflict.

Although the risk of losing lands has remained relatively low, the number of land tenure problems is quite high, especially in Fatick. In 1998 nearly half (45 percent) of the villages surveyed stated that they were undergoing land tenure problems and conflicts.

Table13A: Means of Obtaining Land, by Gender, 1998

Means of obtaining	*Household Head*	*Women*
Inheritance	54%	7%
Grant from the CR	4%	1%
Rented	3%	0%
Borrowed	15%	7%
Bought	1%	0%
Cleared	32%	4%
Grant from the Village Chief	9%	53%
Other	6%	5%

Note: KAP 1998.

Need to check whether comparable data exists from 1992 KAP. Is not in KAP 92 tables.

Where households do obtain land for rural production, stark gender differences exist in how that process occurs. As shown in table 13A, household heads are most likely to inherit land, clear land from fallow or bush, or borrow it. Only 9 percent of men perceive that they need a grant from the village chief to obtain land. In contrast, more than 53 percent of women leaders stated that, if they wanted to obtain land, they would need to pass through the village chief. The Kaolack Agricultural Enterprises Development (KAED) project has demonstrated that women can take advantage of de facto ownership of land resources, especially when combined with pooling of economic resources with other women. Evidence from this part of the KAP survey suggests that future efforts to focus on increasing and facilitating women's access to and ownership of land must address as a priority the process by which they obtain it (or perceive they obtain it) from village chiefs. To the extent that this focusing of land distribution power in the hands of the village chief is a constraint to increased female land ownership and management, it might be addressed or studied further.

G. Awareness of Select Laws and Codes Effecting NRM

Table 14A: Levels of Awareness of Select NRM-Related Laws and Codes

Means of obtaining	*Household Head*	*Women*
New Forest Code	41%	19%
National Domain Law	66%	24%
Regionalization Law	27%	4%
Environmental Code	6%	2%
Water Code	2%	7%
Livestock Movement Code	16%	36%

Note: KAP 1998. Need to define exactly what "awareness" means in this table.

Need to check whether comparable data exist from 1992 KAP. It is not in KAP 1992 tables.
Make a few comments on the regional differences here.
Combine analysis with the correlation coefficients of Forest Code and NRM practices.

As part of the 1998 KAP survey, household heads and women leaders were asked about their levels of awareness of select NRM-related laws and codes. Results from the survey are shown in table 14A.

Most notable about the results concerning awareness of NRM-related laws and codes is *the high level of awareness—at least for men—of the New Forest Code.* That four out of ten rural households should already be aware of the "principal elements" of a law that was only promulgated in 1995 suggests both the law's importance and the success of USAID and GOS efforts to educate the rural populace about it. Through the development of the New Forest Code, USAID played an active role, not only through the Senegal Reforestation Project (SRP), but also through policy support provided by the Mission itself. The relatively high levels of awareness may in some part be attributable to the increased numbers of conflicts between the rural populace and the Forest and Water Department, in particular over cutting of *kad* trees *(Acacia albida)* and rural rights to collect products from forests. A large proportion of those in the rural area, aware of elements of the New Forest Code, may be recognizing new rights granted to them and using this awareness of rights to challenge local agents of the Forest Department.

In all but the laws relating to livestock movement, women are considerably less aware of NRM laws and codes than men, suggesting a fundamental disparity in the processes by which information on these laws is disseminated. *If knowledge is power, men in the target zone clearly have an advantage in areas relating to the Forest Code, the National Domain Law, and the Regionalization Law.* Although the Community-Based Natural Resource Management (CBNRM) project has made special efforts to engage women in the information dissemination process, more committed efforts will be required of USAID and its partners in the process.

H. Ownership of Farm Equipment and Animals

Table 15A: Household Ownership of Farm Animals: 1992 and 1998

Percent Owning		Tamba	Kaolack	Fatick	Kolda	4 REGIONS
Cattle	***1992***	46%	27%	42%	47%	39%
	1998	54%	29%	40%	48%	42%
Sheep	***1992***	57%	64%	48%	43%	54%
	1998	50%	61%	62%	47%	55%
Goats	***1992***	58%	67%	61%	59%	62%
	1998	59%	73%	63%	56%	63%
Horses	***1992***	33%	84%	66%	17%	54%
	1998	30%	82%	64%	20%	50%
Donkeys	***1992***	37%	31%	41%	42%	37%
	1998	42%	41%	45%	46%	43%
Oxen	***1992***	21%	13%	12%	23%	17%
	1998	30%	14%	14%	37%	23%

Note: 1992 data from KAP 1992, Annex IV, page 58

Table 16A: Farming Equipment Owned by Households: 1992 and 1998

Percent Owning		Tamba	Kaolack	Fatick	Kolda	4 REGIONS
Cart	***1992***	31%	51%	57%	27%	43%
	1998	39%	58%	57%	33%	47%
Seeder	***1992***	35%	80%	75%	35%	60%
	1998	35%	79%	70%	48%	59%
Tractor	***1992***	0%	0%	0%	0%	0%
	1998	0%	0%	0%	0%	0%
Sprayer	***1992***	9%	2%	0%	16%	6%
	1998	18%	4%	3%	22%	11%

In general, the proportion of rural households in the target zone owning farm equipment and farm animals did not change dramatically between 1992 and 1998. A number of trends do emerge, however, most notably, the continued increase in ownership of donkeys throughout the

zone and increases in mechanization in the Kolda region. In the past two decades, farmers in the Peanut Basin have gradually replaced the slower ox with the faster horse and donkey, particularly for upland cultivation. Although the KAP survey did not generate statistics for the proportion of farmers using animal traction, it is generally accepted that traction is used for nearly 100 percent of upland planting. Household studies for the region have shown that one key determinant of farm productivity is the ownership of animals for traction, which allows the owners to get a jump start on cultivation of their fields; those who borrow animals must wait until the owners are finished.

Although the number of households owning horses appears to have declined slightly during the 1992 to 1998 period, increases in donkey ownership have continued. In 1992, 37 percent of farm households owned their own donkeys, but in 1998 this figure had risen to 43 percent.

The model of equines replacing oxen appears not to fit for the Kolda and Tambacounda regions in the 1992 to 1998 period, as ownership levels of both of those animals increased. In Kolda, the proportion of households owning oxen rose from 23 to 37 percent in the six years covered by the study, whereas the comparable figure for Tambacounda was an increase from 21 to 30 percent. Oxen ownership increases in both these regions may be explained in part by the need for stronger animals to clear land not previously cultivated. Horses and donkeys are generally not strong enough to clear land that has not been cleared and cultivated in a previous year.

Because of differences in the precise definitions of farm machinery in the 1992 and 1998 KAP surveys (especially sine hoes, single and double mouldboard plows, and combination seeder/weeder/tillers), it is unfortunately not possible to provide an accurate picture of how that ownership has evolved over the period.

Nevertheless, a look at the ownership changes of carts, seeders, and sprayers does provide a consistent point of comparison across the two periods. The most striking result in looking at changes in ownership of farm equipment is the rapidity with which it has increased in the Kolda and, to a lesser extent, Tambacounda regions, especially when compared to the insignificant changes in the Fatick and Kaolack areas. In Kolda, ownership of seeders rose from just over a third of farm households (35 percent) to nearly half (48 percent), whereas cart ownership rose from 27 to 33 percent and sprayer ownership rose from 16 to 22 percent. Such evidence suggests a rapid capitalization of farm production activities in the Kolda region.

V. Distinguishing Between Users and Nonusers of NRM Technologies

A. Context and Approach

The terms of reference asked the team to identify "plausible causes, reasons, purposes, and logic for the use and nonuse" of improved NRM technologies. The terms of reference further require that the team will "identify the geophysical, cultural and religious, and any other determinants related to adoption of specific and individual agricultural practices and natural resource technologies in different agrogeographic zones, rural councils, villages, and households."[8]

Identifying reasons for adoption or nonadoption of NRM technologies is a focus of the analysis throughout the entire SO2 impact assessment report. In this paper, we address the adoption/nonadoption issue by applying statistical analyses to the available 1998 KAP data. The analysis proceeds in two parts: a bivariate analysis (or comparison of two variables at a time) and a multivariate analysis (or analysis of more than two variables at a time).

In the bivariate analysis, which follows below, cross-tabulations were generated between the adoption/nonadoption characteristics and one other characteristic. The objective of the bivariate analysis is to identify those characteristics that distinguish adopters from nonadopters. In the multivariate analysis, a logit regression is run of the adoption/nonadoption variable against five independent variables. The objective of this regression analysis is to better understand which variables are most closely linked with increasing the likelihood of NRM adoption.

For the purposes of this analysis, an "NRM-adopting household" is defined as any that stated it used *at least one* of the following NRM technologies: windbreaks, live fencing, tree planting, alley cropping, composting, erosion-control dikes, anti-salt dikes, tied ridges, retaining dikes, or improved stoves.[9] Using this definition for the KAP sample as a whole, *57 percent of households are adopters, whereas 43 percent are nonadopters.*

[8] Terms of reference (page 9).

[9] The corresponding French terms used in the 1998 questionnaire are *brise vent, haie vive, boisement/vergers, culture en bande, compostage, diguettes anti-erosives, digue antisel, billonage cloisonné, digue de retenue,* and, *foyer amélioré.*

B. Bivariate Analysis: Which Variables Are Associated with NRM Adoption?

1. Approach

For the bivariate analysis, a cross-tabulation of the adopter/nonadopter variable was run against each of the following variables: remittances, ecoregion, knowledge of the New Forest Code, receipt of an extension visit, farm size, use of animal traction, and religious brotherhood affiliation. Results of the analysis are shown in figure 3A on the following page. In the figure, the column entitled "Proportion of Total Sample" indicates the percentage of the total population accounted for by the stated characteristic. The single line running down the center of the figure shows the average proportion of NRM adopters across the total sample. The horizontal bars show the deviation for a given characteristic from the sample average of 57 percent. A "large" green bar suggests that the sample distinguished by the given characteristic is more likely to be an adopter of NRM than the average household.

2. Results

A number of conclusions are suggested by the figure and the results contained therein. Of the variables included in the analysis, *ecoregion appears to have the most pronounced association with adoption or nonadoption.* Only 18 percent of those in the Eastern Transition Region use NRM, whereas 75 percent do in the Casamance (excluding Zuiguinchor) and 54 percent do in the Shield Region. The deviation of the ecoregion results from the sample average is more stark than for any other variable included in the analysis.

As a corollary to the ecoregion observation, one might argue that rainfall has less to do with adoption than previously thought. Rainfall in the Saloum region averages only 300–400 millimeters a year[10] and 63 percent of households in that region are adopters (i.e., well above the 57 percent target zone average). In the Shield Region, in contrast, with 700–1,000 millimeters a year of rainfall, only 54 percent of the households are adopters. Across the ecoregions, the one with the highest proportion of NRM adopters is the Casamance (primarily in Kolda), where 75 percent of households use NRM. This figure is higher in part because of the appropriateness of some of the water management technologies in that region (which are simply not applicable at much lower levels of rainfall).

One of the more striking results of the analysis was that *those households that had received an extension visit in the previous cropping season were much more likely to be adopters of NRM technology than those that had not.* "Extension" as used here, is not limited to government extension agents, but includes anyone promoting the use of improved technologies for farming. Of the 23 percent in the sample population that had

[10] Rainfall averages are from the period 1990–94. See rainfall zone map earlier in this report.

Figure 3A: Distinguishing Characteristics of NRM Technologies Adopters

someone —translating directly from the questionnaire— "visit their field the previous season to discuss the agricultural problems that you have," 68 percent were users of NRM technologies. Among the 77 percent of the sample that had not received such a visit, far fewer (55 percent) used NRM technology. Such statistics support the assertion that agricultural and NRM extension, when properly conducted (i.e., through actual visits to farmer's fields), can be associated with notably higher levels of NRM adoption.

Of course, these statistics are by no means causal, because self-selection may be an element. Those households that use NRM may be more likely to invite or encourage extension personnel to discuss technologies with them. But, in spite of this caution, the close link between NRM adoption and extension visits should be taken seriously.

Households with more adult laborers were more likely to be users of NRM technologies, in part because of the labor intensity of many of the NRM technologies. Although households with fewer than nine working-age adults were about as likely to be NRM adopters as the average, 67 percent of those with nine or more working-age adults were NRM adopters.

Another characteristic distinguishing NRM adopters from nonadopters is the receipt of remittances. *Those households that claimed to have received more than 25,000 FCFA in the twelve months prior to the survey were more likely to be adopters of NRM;* their percent of NRM adoption was 64 percent. Of those households that had not received more than 25,000 FCFA in the previous year, only 56 percent were NRM adopters.

A number of variables are notable for not having a significant association with NRM adoption. The team had hypothesized that those households with large farms, ownership and use of animal traction, and knowledge of the New Forest Code might be more likely to adopt NRM. In fact, although larger farms do appear slightly more likely to be NRM users, the difference between them and small farms (2 hectares or less) is minor. Similarly with animal traction, for which virtually no difference exists in NRM adoption between those that own animals for traction (58 percent adopters) and those that do not (57 percent of adopters). It was assumed that knowledge of the New Forest Code might encourage NRM adoption by providing greater security to those interested in using tree-based technologies to stabilize or improve productivity. As with the animal traction variable, however, virtually no difference existed with respect to adoption for those who knew the Forest Code and those who did not.

It is often claimed that Muslim religious brotherhoods may be an important explanatory factor in understanding NRM adoption. As part of the 1998 KAP survey, respondents were asked with which Muslim brotherhood they were affiliated, if any. Cross-tabulation of these results with NRM adoption suggests that little difference exists between the different brotherhood's members when it comes to NRM adoption.

C. Multivariate Analysis: Which Variables Contribute Most to Increasing the Likelihood of NRM Adoption?

1. Approach

The Government of Senegal and USAID as its partner have a choice of policy and programmatic "levers" they can use to increase the adoption of NRM in rural areas and, as a consequence, try to improve the quality of rural resource management. When USAID or GOS contributes to a change in one variable (for example, the amount of credit available), that action also has an impact on other variables. In the preceding section, the bivariate analysis consisted of direct comparison of two variables—adoption/nonadoption and one other variable—without any control for other variables. The objective of this analysis is to identify and quantify the effect of certain changes in rural households on the likelihood of NRM adoption, while holding other variables constant. Because more than two variables are involved, this is called a multivariate analysis. The objective of this analysis, put another way, is to try to determine which of a number of those levers would contribute most directly to increasing NRM adoption and, by assumption, the present and future quality of natural resources.

The policy and programmatic levers available to GOS and its partners are manifold, but, ultimately, they act by changing the way households use their labor, land, and capital. For this analysis, we look at the following specific characteristics of households in the target zone.

- *Adult labor:* the number of adult laborers in the household in 1998
- *Area planted:* the hectares of area planted in the 1998 cropping season
- *Remittances:* the value 1 for households that received more than FCFA 25,000 remittances in 1998; 0 if not
- *Traction animal ownership:* the value 1 if the household owned its own traction animals (donkeys, horses, or oxen) in 1998; 0 if not
- *Ecoregion:* a control variable for each of the major ecoregions in the target zone, of which six exist.

Our objective was to estimate how changes in these six variables result in increases or decreases in the probability of NRM adoption. The probability of adoption is bound by the values 0 and 1. In addition, the variables that we believe may have some impact on the probability of adoption are not necessarily linearly related to the likelihood of adoption, thus, making an Ordinary Least Squares (OLS) regression inappropriate. In such cases, however, we can use the logit model.[11]
As per the logit model, the total probability of NRM adoption can be expressed as follows:

[11] I am particularly grateful to Jeff Cochrane, SETA Corporation senior analyst, and Carol Irvin, researcher at Mathematica Policy Research for the assistance they provided in the elaboration of this analysis. Any errors that might be found in the analysis, however, are in no way attributable to them. For further discussion of logit models, see Damodar N. Gujarati, Basic Econometrics (McGraw Hill: New York, 1998), pages 481–91.

$$P_i = E(Y=1|X_i) = 1 / \{1+e^{-(\beta' Xi)}\}$$

Where the β are the coefficients of the independent variables and the Xi are their values.

Having estimated the values of the coefficients—which was done for this exercise using the "SAS" statistical package—we examine how the total probability of NRM adoption changes as we test different values of the independent variables.

The data set for this analysis is virtually the same as that for the preceding bivariate analysis; the only difference is that a small set of household values for ecoregions with very small samples was excluded from the data set used in this analysis.

To conduct this testing procedure, we proceed in two ways, first by assessing changes in labor, the area planted, remittance and traction variables, while holding the ecoregion constant at average values. Using the results from the bivariate analysis to help us identify key values, we have created a "base case" and "test case" for each of the four variables. In a second test, we hold each of the four programmatic variables constant at the "base case" used in the first analysis and then change the ecoregional values; that is, for the first of the ecoregional tests, we put the West-Central Xi value equal to 1 and the remaining ecoregional values to 0 and then calculate overall NRM adoption probability. The same process is followed for each of the regions, and overall NRM adoption probability is compared.

2. Results

The results shown in table 17A [see page 36] confirm the results from the bivariate analysis, but with greater statistical reliability. Other things being equal, ecoregional variables have a greater impact on the likelihood of adopting NRM than any of the other variables included in the analysis. *Even after controlling for land, labor, and capital differences, the analysis suggests that households are far more likely to adopt NRM when living in the Casamance ecoregion than when living in the Eastern Transition ecoregion.* Rural households in the Casamance have a probability of 0.77 of being NRM adopters, even after controlling for the four other variables.

Ecoregions are in effect characterized by a combination of land quality, rainfall, and general ecological conditions. The implications of these results are important, in that they suggest that a household's allocation of economic assets may be less important in determining whether it uses improved natural resource management practices than the endowment handed to the household simply by virtue of where it lives.

Among the four variables over which a household may have greater control (assuming it is not prepared to move to another ecoregion), the adult labor and remittance variables go furthest in explaining increases in adoption of NRM. Households that receive more than

FCFA 25,000 per year in remittances, other things being equal, are considerably more likely to adopt NRM than are those households without such available funds. These results reflect the reality that investing in NRM requires a significant amount of capital.

A number of policy implications for USAID and GOS are raised by these results:

- The importance of capital access and capital markets should not be ignored if USAID hopes to improve natural resource management.

- The analysis confirms that labor shortages are one of the primary constraints to increasing NRM adoption and that resolution of this constraint contributes directly and significantly to increasing NRM adoption. Future technology proposals should, therefore, pay special attention to this labor shortage.

- In spite of the apparent decline in land quality in the Saloum, the overall probability of NRM adoption increasing in that ecoregion and the consequent potential for NRM impacts is higher there than in any other ecoregion in the target zone except the Casamance. And this result is true even after accounting for land quantity, labor availability, and capital access differences.

- No conclusive evidence exists that directing NRM programs to large rather than small farmers or to traction animal owners rather than non–traction animal owners, will have any significant impact on changing NRM adoption.

Table 17A Results to Logit Analysis of KAP 98 Data on Probability of NRM Adoption

Characteristic	*Adult Labor*	*Area Planted*	*Remit-tances*	*Animal Traction*	*West Central*	*Ag Exp-ansion*	*Saloum*	*Eastern Trans'n*	*Shield*	*Casa-mance*	*Probability of Adoption*
	(1)	*(2)*	*(3)*	*(4)*							
Units	# Adults	# Hectares	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	
Possible values in regression	Continuous	Continuous	1 or 0	1 or 0	1 or 0	1 or 0	1 or 0	1 or 0	1 or 0	1 or 0	
Base value in calculations	5	2	0	0	0.20	0.09	0.23	0.11	0.15	0.20	
Tested value in calculations	12	8	1	1	0.20	0.09	0.23	0.11	0.15	0.20	
Meaning of tested value	More adult laborers	More planted land	More than FCFA 25,000 remittances	Owner of traction animals							
Estimated coefficient	0.03	0.02	0.23	-0.17	0.22	-0.30	0.39	-1.64	0.09	1.00	
Test 1: Alter Variables (1) - (4) and Hold Ecoregions at Average Values											
Base Case	0.16	0.03	0	0	0.04	-0.03	0.09	-0.18	0.01	0.20	***0.58***
Test Labor	0.39	0.03	0	0	0.04	-0.03	0.09	-0.18	0.01	0.20	***0.64***
Test Area Planted	0.16	0.12	0	0	0.04	-0.03	0.09	-0.18	0.01	0.20	***0.60***
Test Remittances	0.16	0.03	0.23	0	0.04	-0.03	0.09	-0.18	0.01	0.20	***0.64***
Test Animal Traction	0.16	0.03	0	-0.17	0.04	-0.03	0.09	-0.18	0.01	0.20	***0.54***
Test 2: Hold Variables (1) - (4) at "Base Case" Values and Alter Ecoregion Values											
West-Central	0.16	0.03	0	0	0.22	0	0	0	0	0	***0.60***
Ag Expansion	0.16	0.03	0	0	0	-0.30	0	0	0	0	***0.47***
Saloum	0.16	0.03	0	0	0	0	0.39	0	0	0	***0.64***
Eastern Transition	0.16	0.03	0	0	0	0	0	-1.64	0	0	***0.19***
Shield	0.16	0.03	0	0	0	0	0	0	0.09	0	***0.57***
Casamance	0.16	0.03	0	0	0	0	0	0	0	1.00	***0.77***
Standard Error	0.02	0.02	0.17	0.18	0.23	0.28	0.23	0.29	0.21	0.21	
t-statistic	1.4	0.9	1.3	-0.9	0.9	-1.1	1.7	-5.6	0.4	4.7	

Note: (1) For purposes of presentation, figures have been rounded to two decimal places.

VI. Conclusions and Recommendations

USAID's KAP surveys during the period 1992 to 1998 provide a unique source of data about changes in households' perceptions and use of NRM technologies. Indeed, few if any similar data sets exist in the Sahel that allow for both time series and cross-sectional analysis over such a large geographic area and diverse a population. The KAP survey designers in 1991 created the tool with the objective—among others—to generate information that would allow analysts to estimate the factors that would contribute to increasing the likelihood of technology adoption among the target population. Now, seven years after the first survey, such an analysis has become possible and has been completed and included here. The KAP information is a rich mine of information about NRM changes in Senegal and merits further analysis beyond what was possible in this report. In this final section of the report, we draw a number of conclusions and recommendations from the analysis of KAP data.

A. Changes in Adoption Levels of NRM Technologies

Between 1992 and 1998, USAID's SO2 program attempted to create the conditions for broadly based increases in improved NRM technology adoption in the Kaolack, Fatick, Casamance, Kolda, and Tambacounda regions of Senegal. One of the objectives of the KAP analysis under this SO2 impact assessment report is to analyze KAP surveys from the years 1992, 1994, 1996, and 1998 to assess whether NRM adoption had increased or decreased during the period. Notwithstanding a number of methodological constraints in measuring NRM change with the KAP, a series of conclusions can be drawn about changes in NRM adoption levels during the period.

Throughout the target region analyzed in this SO2 impact assessment, adoption levels of many key NRM technologies clearly increased during the period 1992 to 1998. Leading these increases were windbreaks, planting of field trees, improved stoves, live fencing, composting, and a variety of water management technologies. Anecdotal evidence from field visits by the SO2 impact assessment team confirms these upward trends in technology adoption.

By 1998 one of the key indicators of NRM technology awareness and interest—planting of trees in fields—was being done by nearly half (43 percent) of rural households. Although many of these trees were mango or citrus rather than those species more commonly recommended by NRM experts, this level of active resource management investment is quite high. Use of two other technologies commonly recommended under NRM programs supported by USAID—live fencing and windbreaks—also grew during the study period, but did not reach the same levels of proliferation as tree planting. In 1998 only 18 percent of farmers were using live fencing, whereas 11 percent were planting windbreaks. Water management technologies appeared to increase in use during the target period, but were still at rather low levels of adoption throughout

the zone by 1998. Further study would be required to compare the number of water management technology adopters to the number of households with land for which water management technologies would be appropriate in the first place.

Although some upward bias exists in time series comparisons of NRM technology adoption between 1994 and 1998, cross-regional comparisons of adoption levels generated from 1998 KAP data do not suffer the same biases. The region with the largest levels of NRM technology adoption increases was Kolda, where two technologies increased in use by more than 40 percent during the period (assisted regeneration and field tree planting) and five increased by more than 20 percent (the previous two plus water retention dikes, anti-erosion dikes and plantations and orchards). Although some technologies saw large increases in Kolda, others declined. Included in the list of technologies for which use declined in the period were alley cropping, nursery techniques, windbreaks, and improved seed.

NRM technology adoption increases were the most consistent and widespread in the Fatick and Kolda regions, where virtually all of the "leading" technologies measured saw increases during the period of study. The size of these increases, however, was relatively smaller than in Kolda. The Tambacounda region, much of it falling in the Agricultural Expansion or Eastern Transition Ecoregions, saw much lower levels of technology adoption increases than the other areas of the country.

B. Evolution of the Conditions for NRM Technology Adoption

The KAP analysis looked at a host of variables in addition to technology adoption, most of which were selected to shed light on the conditions for technology adoption and more generally the conditions for rural household production. A number of conclusions emerge from the analysis:

Increased effectiveness in delivery of NRM-related extension messages. KAP evidence suggests that NRM and agricultural extension services reached more people in 1998 than in 1992 and that the impact of this increased number of visits was both real and measurable. Included in these "extension services" was not only GOS extension agents, but also all NGOs and project personnel, including those supported directly and indirectly by USAID's program assistance. In 1992, 47 percent of households in the target zone received NRM/agricultural extension visits. This figure had risen to 53 percent by 1998. Further analysis included in this study suggests that receiving a visit from an extension agent was a critical determining factor in whether or not households adopted NRM. Among those households that did receive a visit to their fields by an extension agent, 68 percent adopted one of the improved NRM technologies. Of those that did not receive a visit, in contrast, only 57 percent adopted NRM. In sum, more households received extension visits, and those that did receive them were more likely to adopt NRM.

Continued investments in labor-saving farm animals. A long-term term trend toward continued investment in labor-saving farm machinery is apparent in the period 1992 to 1998. Households throughout the target zone increased their investments in donkeys, whereas Kolda and Tambacounda saw increased ownership levels of oxen.

Gender differences in access to capital and awareness of laws and codes. To the extent that access to capital is an important determinant of NRM adoption, women would appear to be at a special disadvantage, because the KAP shows that women are less likely to receive credit than men. Programs such as KAED are taking important steps to resolve this constraint. Similarly, women are less likely to be aware of key laws and codes concerning natural resource management than their male household counterparts. This gender bias in capital and information access emerges as an important constraint to expanded NRM adoption by women.

Extent and concentration of NRM financing by the rural council. The Mission's upcoming decentralization SO focuses on facilitating the means by which rural councils can provide financing for NRM activities. Evidence from the 1998 KAP shows that the baseline values for this rural council support are presently quite low. Across the target region, only 11 percent of villages surveyed had received any financing for NRM from the rural council. The region with the highest proportion of villages receiving such financing was Fatick (18 percent), whereas the comparable figure in Kolda was only 5 percent. Such figures suggest an important space for upward expansion of the role of the councils. It also raises the issue of alternative sources of financing for NRM activities, and the need to analyze the costs and benefits of facilitating additional financing flows through these mechanisms.

Continuing shortage of labor for rural production. One of the persistent myths of household production in Senegal is that a surplus of available rural labor exists. Although formal sector employment statistics may support this myth, evidence from informal production in the rural sector and from the KAP analysis here do not. Statistical analysis of NRM adopters shows that one of the key constraints to household adoption is whether the household has access to sufficient labor. This constraint appears to be more important than the amount of land a household has available to it and possibly more important than their ability to access capital. Present and future NRM and environmental programs in Senegal should pay special heed to this constraint. A number of successful activities have combined, for example, labor-saving income-generating activities with NRM practices that do not require heavy amounts of labor during the cropping season.

Continued investment by households in animal traction. In each of the regions of the target zone, the proportion of households purchasing donkeys and oxen increased during the period 1992 to 1998. These two animals, used primarily for animal traction, represent a significant cost to the rural household, yet can reap important labor-saving rewards. For example, in many other Sahelian countries, increased access to donkey carts has made it feasible for rural populations to invest more efforts in the construction of stone lines and other erosion control structures, and to transport poles, fuelwood, garden crops and other farm products to more

distant markets more economically. Future private sector demand assessments should pay special attention to this household investment trend, in particular by paying special heed to what this pattern suggests about the importance of the labor constraint and by what it offers in terms of opportunity for the increased adoption of NRM and related income-generating practices.

C. Factors Affecting the Likelihood of NRM Technology Adoption

Although many studies have measured adoption levels of NRM technologies in the Sahel, few have used these data to distinguish between those households that adopt NRM and those that do not. How does the average household that uses improved NRM technologies differ from those that do not? NRM program development—not to mention program development in other rural sectors—could benefit from development of a market profile of NRM users. In this report we have used 1998 KAP data in an effort to create this market profile and, more generally, to determine what it is that makes NRM adopters different from the rest of the rural population.

The analysis proceeds in two stages. First, we make a direct comparison of adopters to nonadopters on a variable-by-variable basis, which we term a bivariate analysis. For a given variable (for example, farm size), we correlate it to whether or not the household was an NRM technology user or not.

Second, using a logit regression model, we proceed to conduct a multivariate analysis of the distinguishing characteristics of NRM adoption in the target zone. The purpose of the logit regression modeling is to understand which characteristics of rural households contribute most to the overall likelihood of NRM adoption. Armed with this information, a program implementer might target activities toward those households that would promise the greatest impact per program dollar spent. A number of conclusions and recommendations emerge from the two related analyses.

Overall NRM adopter profile. The rural Senegalese household that uses NRM will, on average, be distinguished by a number of characteristics. Compared with the average rural household, it will be *(a)* more likely to be in regular touch with extension workers (of NGOs, government, or other institutions), *(b)* more likely to have many (more than nine) adult laborers, *(c)* more likely to have received regular off-farm remittances and, *(d)* more likely to be from either the Casamance or the Saloum ecoregions.

Fundamental importance of ecoregional endowment. The ecoregional endowment facing a rural household contributes more to the likelihood of their adoption of NRM than any other tested variable. All other things being equal, 77 percent of households in the Casamance ecoregion (excluding Zuiguinchor) can be expected to use NRM, whereas only 19 percent can be expected to use it in the Eastern Transition Ecoregion. Program planners working in the Eastern Transition Ecoregion would be wise, given these facts, to ask whether the value per dollar spent in trying to increase NRM adoption there is worth it given other opportunities

elsewhere. The CBNRM project has paid attention to the importance of ecoregions, including it as an important factor in their KAPs and monitoring and evaluation work. In addition, it is worth noting that these ecoregions as defined do not necessarily overlap closely with rainfall, which has often been referred to as a critical determinant of NRM use. Rainfall in the Saloum is not much different from the Agricultural Expansion Ecoregion, but the likelihood of NRM adoption is considerably different (64 percent compared with 47 percent). Other factors, such as land use pressures, demographic pressures, access to investment capital, labor and markets, seem to exert a greater influence than rainfall.

Importance of access to capital via remittances. Both the bivariate and multivariate analyses highlighted the important link between access of households to remittances of more than FCFA 25,000 and adoption of NRM technologies. Although remittance declarations are not highly reliable as point estimates, we believe the categories used for the analysis are broad enough to reflect a general difference among households with access and nonaccess to this capital. What is unclear, of course, is the causal link between a household having more accessible capital and its investment in NRM technologies. Is a household more likely to invest in NRM because it has access to capital and because NRM investments require more capital? Or, is the household with access remittances also the same household with the connections to the world beyond the village that would allow it to be more aware of NRM technologies than other households? Or are the NRM investments paying off and contributing to the increased access to capital?

Labor and NRM technology adoption. A household with eight or less adult laborers is less likely than the average household to use NRM technologies. But, as the number of adult laborers rises above eight, the likelihood of them using NRM rises rapidly. Sixty-seven percent of the households with nine or more adult workers use NRM, whereas between 55 and 57 percent of those households with eight or fewer laborers use it. This characteristic of NRM technology adopters might also be used in the process of targeting current and future NRM programs.

Apart from any specific conclusions about which variables increase the likelihood of adoption, the statistical analysis conducted here raises the important question of precisely how target populations are defined during program or project design and elaboration. What are the exact target populations of the private sector and decentralization programs? And what is the hypothesized causal linkage between what those programs do and the measurable impact they have on changing the behavior of those target populations? The analysis included here suggests that thinking carefully about the characteristics of subsets of the overall rural population can be an important means of enhancing program success. We would recommend that future USAID programs take the time to look into these characteristics and carefully define the "consumer profiles" of the target populations they hope to change or affect.

D. Design and Implementation of the KAP Surveys and Linkages to Environmental Monitoring

A number of lessons emerged from this study about the way in which KAP surveys and environmental monitoring tools can and should be used by USAID. Key conclusions and recommendations are summarized here:

Correlation between program size and long-term impact monitoring with KAPs. Each of the KAP surveys of 1992, 1994, 1996, and 1998 cost between US$50,000 and US$80,000 to implement and analyze. In four years, a rough estimate of the cost of implementing the four KAPs would therefore be around US$300,000**.** To this should be added some portion of the environmental monitoring program of the CSE and USGS, which was to contribute information necessary to the tracking of impact of USAID's NRM portfolio. Even including the cost of the CSE/USGS program, USAID's total commitment to impact monitoring is still below 5 percent of the SO2 program, the standard level included in World Bank guidelines. In sum, the resources dedicated to the KAP surveys has not been sufficient to design and implement surveys with the precision and quality required to track SO2 on a sustained basis. The specific funding constraint applies not so much to the implementation of surveys on the ground, but rather to their design. In each of the KAP surveys, the following areas have not been given sufficient attention or resources: sample design, integration of sampling approach with other surveys, questionnaire design, spatial aspects of the survey, intended survey outputs, computer summary systems, data storage strategy, and data analysis and reporting.

Linkages between KAP survey information and the long-term environmental monitoring program have been lacking. Prior to the 1998 KAP survey, the KAP process was little integrated with the environmental monitoring work under the CSE/USGS project. The outcome of the lack of integration is evident. It has been difficult for the CSE/USGS experts to gain access to the KAP data of earlier years. KAP surveys have not included spatial coding on questionnaires, and sampling approaches were designed without regard to spatial issues. Issues covered in the KAP surveys do not directly link with the data layers in CSE/USGS maps. In spite of incompatibilities, however, the potential for linking the existing KAP data series on households with spatial information is real and should be pursued further. Concentrations of high probability NRM adopters might be mapped, as could a variety of other NRM characteristics. USGS work on GIS software training should be extended to the designers and implementers of future socioeconomic surveys. Experts from USGS and McGill University might be engaged to deepen the analytical work they undertook to begin linking KAP survey data with spatial information.

Linkages between household KAP monitoring conducted by different SO2 projects. USAID has encouraged its programs to invest in proper and consistent monitoring of NRM impacts and conditions. Many good examples of this work exist, the most notable being the monitoring work of the CBNRM project and the KAED project. But in spite of these good

individual efforts, the SO2 has suffered from a lack of overall coordination in these project-level impact monitoring efforts. One of the issues of greatest interest to the Mission was the ability to compare the impacts of the SO2 program in areas in which one of its projects was active to another comparable area in which the SO2 was not active. But two major obstacles have made this type of comparison difficult. First, no systematic effort was made to identify the precise areas in which each of the SO2 projects was active in villages. Without these maps or, at least, lists of villages where SO2-funded programs were active, it is difficult to create a "with" and "without" set of villages or households to survey. Second, project surveys generally focused only on villages in which those projects were active without surveying another set of villages in which the project had no activities at all. USAID, in its role as coordinator of the program, might have dedicated more resources to the coordination of these project-based monitoring efforts. In the future, greater effort should be devoted to integrating a range of survey and monitoring tools to gather the full range of socioeconomic and biophysical information needed to monitor the evolving context for NRM program investment as well as the impacts of these programs and the ways and means to optimize those impacts and improve program management.

E. Assessing the Impact of USAID's SO2 in the Period 1992 to 1998

USAID was among the major financial supporters of NRM technology development and diffusion in the target zone in the period 1992 to 1998. During this period, available KAP evidence suggests that adoption of NRM technologies increased. Direct and scientifically proven attribution of these increases to USAID's assistance is not possible in light of the measurement issues addressed above. At the same time, two major reasons exist for thinking that USAID's assistance played a role in the technology expansion during the period. First, available evidence on NRM adoption highlights the importance of extension to the adoption process. Those who had received extension visits were considerably more likely to adopt NRM technologies than those who had not. USAID's program supported both field visits (through such projects as KAED, SRP, and Rodale) and the development of technologies that would be appropriate for extension dissemination (such as natural resource–based agricultural research and Rodale). In short, USAID places special emphasis on getting out and meeting with rural households to develop, adapt, and disseminate NRM messages and technologies, and those households were much more likely to adopt NRM than were other households. A second reason for thinking that USAID's SO2 contributed to an increase in NRM use during the period is the substantial scope of the SO2 program and size of USAID investment compared with other programs and donors. One might argue that, without the involvement of USAID during the period, the level of knowledge about NRM in public and private research and extension networks may not have increased as rapidly as it did.

F. Implications of the KAP Analysis for Current and Future USAID Programs

Taken together with the contextual information and other data reported in the overall SO2 assessment report (including the "Limited Scope" Impact Assessment Report (May, 1998) and Volumes 1 and 2 of this full Impact Assessment report), the information and analysis included in this KAP analysis is very useful to USAID's upcoming decentralization and private sector programs because it provides an understanding of the dynamics of rural production and a snapshot of the rural sector in 1998. The information that is especially pertinent to the decentralization program is that concerning rural council financing of NRM activities, knowledge levels of the rural population concerning key laws and codes, perceptions about which rural institutions are responsible for conflict resolution, and the extent and types of community-based NRM activities. The private sector program will most likely have even more to gain from this analysis than the decentralization program. In its efforts to broaden market accessibility in the rural sector, the private sector program could benefit from information about the following issues: market penetration of select technologies, gender-disaggregated data on access to capital markets, and ownership levels of key household productive assets (especially farm equipment, farm animals, available land, and available labor).

One area of particular importance is the use of forest products from common lands. The evidence is strong that the *economic or social importance of common area forests to rural households is greater now than it was only seven years ago.* This increased importance suggests that organization of communities around initiatives to protect tree cover and manage the remaining areas of national forest may be more likely to meet with success now, a conclusion with implications for the new SO2 on decentralization. The evidence here also makes it clear that enhancing certain private sector market opportunities—such as for fruit and nut sales, honey collection and sale, and animal feed and fattening—may have immediate repercussions for common area resource conservation. Future SO1 activities, therefore, will need to pay special attention to ensure that the products targeted for increased sales and distribution are gathered and produced in a way that is consistent with common area resource conservation.

This analysis also contributes to USAID's new programs by providing input into the methodological issues concerning how new programs can learn from the monitoring efforts of the past, particularly through the use of large-scale household surveys. Because both of the new programs are being launched at approximately the same time, it may be wise to include a core baseline survey instrument of the rural sector that could serve as a point of departure. Design of such an instrument would have much to gain from the lessons learned on the 1992–98KAPs, and would be able to borrow significantly from select elements of those KAPs. The leading lessons to take into account in any effort to create a new baseline survey are to spend more time and money on the following issues:

- *On sample design and sample selection, ensure statistical and methodological consistency with environmental monitoring surveys, other KAP and project surveys, and demographic and health surveys.*
- *Make use of past lessons learned and data in design of future surveys*. Those involved in past USAID-funded surveys should be consulted in the design of future surveys, even if they are not to play any role in survey execution.
- *Develop local capacity and support local participation in the survey process; make provisions for involving stakeholders in the survey design and in the discussion and analysis of survey results.*
- *On questionnaire design and testing, develop detailed translations of the questionnaire, at least for key words, into local languages*. Catalogue and field test specific definitions of concepts. Ensure that all questions included in the questionnaire will be utilized in the final analysis.
- *Develop small software procedures for data management, analysis, and report production.*
- *Ensure that the surveys respond to the program management needs of the implementing agencies and program beneficiaries, and are not simply driven by the needs of reporting to USAID/Washington*; this will promote greater local ownership and increased attention to the usefulness and quality of the results.
- *Ensure that the survey data are well managed and accessible to interested parties and that the survey results are disseminated in an appropriate manner.*

Above all, future surveys and related impact monitoring efforts should be allocated sufficient resources to both generate statistically sound information and to provide for data analysis, information management and reporting so that the information can be used for future program management and impact assessment.

VII. Annexes

Annex A

Comparison of KAP Questionnaires from 1992, 1994, 1996, and 1998

Annex B:

Terms Used to Define NRM Technologies in the 1992, 1994, 1996, and 1998 KAP Surveys by Xiuping Duan

Annex C:

1998 KAP Questionnaires

Annex D:

Estimates from KAP of Area Planted in Tambacounda,Kaolack, Fatick and Kolda for the Period 1992 to 1998

Annex E:

Supplementary Maps Generated from 1998 KAP Data